2014

Elliott Carter and his use of metric and temporal modulaton in his Eight Pieces for Four Timpani : an examination into the application of click tracks during the preparation and performance of these works

Tegan LeBrun
Edith Cowan University

Edith Cowan University

Copyright Warning

Elliott Carter and his use of metric and temporal modulation in his *Eight Pieces for Four Timpani*: An examination into the application of click tracks during the preparation and performance of these works.

Tegan LeBrun

Western Australian Academy of Performing Arts

Edith Cowan University

This dissertation is submitted for the degree of Bachelor of Music Honours

Declaration

I certify that this thesis does not, to the best of my knowledge and belief:

i. incorporate without acknowledgment any material previously submitted for a degree or diploma in any institution of higher degree or diploma in any institution of higher education;
ii. contain any material previously published or written by another person except where due reference is made in the text of this thesis;
iii. contain any defamatory material;
iv. contain any data that has not been collected in a manner consistent with ethics approval.

.

Abstract

Elliott Carter's *Eight Pieces for Four Timpani* have become integral works in the solo timpani repertoire. They continue to offer technical and musical challenges to both developing and professional players and have influenced the development of the solo timpani genre to date. These pieces contain metric and temporal modulation – musical processes which alter certain performance parameters concerning pulse and subdivision tempi.

This dissertation investigates Carter's use of metric and temporal modulation in his *Eight Pieces for Four Timpani* and examines the effects click track application has on the performance of these works. A brief biography of Carter and his use of these techniques is included in this dissertation, as is a succinct history of the *Eight Pieces for Four Timpani*. The paper also contains an analysis of the five works that contain such modulations (*Saeta* (1950), *Recitative* (1950), *Improvisation* (1950), *Canaries* (1950) and *March* (1950)), referring to musical examples and discussing how the performer may navigate some of the more complex modulations. Furthermore, various recordings of *Improvisation*, including those of my own performances, have been analysed in order to support the need for click track for these works, as well as demonstrate the effects applying the tracks will have on the rhythmic accuracy of a performance.

My performance of *Improvisation* has been recorded and analysed three times in this paper – an initial performance (prior to any click track application), a performance with the click track and a final performance (post- click track), with the aim of discovering whether or not these click tracks do indeed influence rhythmic accuracy in each recording.

This dissertation not only endeavours to provide a thorough rhythmic analysis of Carter's *Eight Pieces for four Timpani* and investigate the use of click tracks with these works, but also aims to create a resource that is able to be used by future students who wish to play this repertoire.

Acknowledgments

I wish to thank my supervisor, Lindsay Vickery, for all of his knowledge and guidance throughout the writing of this dissertation. Thank you for everything this semester Lindsay – parts of this project would not have been possible without your help.

To my instrumental tutor and co-supervisor, Tim White – what a journey my time at WAAPA has been! I have had so many wonderful experiences during my studies in the percussion department – the friends I have made and the memories I have are some of the fondest in my life and a huge reason for that is you. Your encouragement and wisdom have helped me to develop into a better musician and your enthusiasm and dedication to myself and the rest of the percussionists at WAAPA has inspired me on both a professional and personal level. Thank you so much for everything Tim!

To my family and friends – thank you for all of your support not only during this project but throughout my life. Having such a strong support network has allowed me to accomplish so many things and reach heights I never thought possible. Thank you.

Table of Contents

Table of Figures

Introduction

Elliott Carter's *Eight Pieces for Four Timpani* have become crucial works in the solo timpani genre, playing an important role in its development. They were among the first solo timpani works to explore and manipulate the timbral qualities of the instrument and effectively incorporate extended techniques. They also contain metric and temporal modulation - musical processes which alter certain performance parameters concerning pulse and subdivision tempi. The current literature provides many definitions of 'metric modulation' but these definitions are often over – simplified and generalized or somewhat contradictory. Furthermore, little distinction is often made between 'metric modulation' and 'temporal modulation', with scarce mention of the latter except to acknowledge that it was a term used and preferred by Carter himself.

The Oxford Concise Dictionary of Music and Musicians describes the process of 'metric modulation' as a "term and technique introduced by Amer. Composer Elliott Carter for changing the rhythm (not necessarily the metre) from one section to another."[1]

In "The Music of Elliott Carter" by G.F Goldman, it is defined as "a means of going smoothly, but with complete accuracy, from one absolute metronomic speed to another, by lengthening or shortening the basic note unit."[2]

Another literary source explains the technique as follows:

> "..a change (modulation) from one time signature/tempo (meter) to another, wherein a note value from the first is made equivalent to a note value in the second, like a pivot. The term was invented to describe the practice of Elliott Carter, who prefers to call it temporal modulation.
>
> For metric modulation to exist 3 things have to occur:

1. There has to be an exact relationship between two different tempi
2. A common pulse must exist between these two tempi
3. The name and function of the pulse changes."[3]

For the purposes of this dissertation, the following definitions apply when referring to the terms concerned:

> Time System: *The combination of pulse tempo and subdivision tempo*.
>
> Metric Modulation: *The transition from one time system to another through a common musical parameter (either through a common subdivision tempo or a common pulse tempo), resulting in a change of metre and the formation of a new time system. The goal of this process is to change metre; overall tempo may be effected but is not a necessary outcome.*
>
> Temporal Modulation: *The transition from one time system to another through a common musical parameter (either through a common subdivision tempo or a common pulse tempo), resulting in a change of metre and the formation of a new time system. The goal of this process is to affect the overall tempo, be it through acceleration or deceleration. Metre is also affected in order to achieve this.*

[1] *Oxford Concise Dictionary of Music*. Oxford, UK: Oxford University Press, 2004.
[2] Richard Franko Goldman, "The Music of Elliott Carter," *The Musical Quarterly* 43, no. 2 (1957). 161
[3] Carter, Elliott, and Lorraine Vaillancourt. *Elliott Carter*. University of Rochester Press, 2001.

Metre: "*The **pattern** of regular pulses (and the arrangement of their constituent parts) by which a piece of music is organized."*[4]

Click Track: *A combination of clicking and percussive sounds, each representing an element or function of the beat. These sounds are combined into a track to be used as a custom – made 'metranome' for that particular piece.*

This dissertation investigates Carter's use of these processes in his *Eight Pieces for Four Timpani* and examines the effects that click tracks have on the preparation and performance of these works. Analysis of three recordings of 'Improvisation' (performed by well-known percussionists Sylvio Gualda, Daniel Druckman and Florent Jodelet) will be presented in order to support the argument that click tracks are a valuable tool when preparing these pieces. Three recordings of my performances of 'Improvisation' (an initial performance, with the click present and post-click track) have also been analysed, with the results demonstrating the effects/ influence the tracks have had on each performance.

This analysis is primarily concerned with the execution of the modulations present and the overall rhythmic accuracy of each recording. However, it is acknowledged that rhythmic accuracy is not the only component that needs to be considered when judging whether or not a performance is effective, nor is it necessarily the most musical option available to the performer. Furthermore, I am aware that music as a performance art is very subjective by nature and that many works are open to interpretation, meaning that timing and rhythmic accuracy may not be of high priority to some performers. I have chosen to simply acknowledge the issues relating to musicality and an effective performance rather than delving into them further as it is likely a topic to be discussed in another dissertation. I will primarily investigate the rhythmic qualities of Carter's *Eight Pieces for Four Timpani* in this paper.

In line with this, it is apparent that there may be better ways to test the effectiveness of the click tracks in terms of increasing the rhythmic accuracy of a performance. Testing them on other players with varying degrees of experience and comparing the results would likely prove to be a more fruitful experiment method. However, due to the time constrains attached to this project, I have elected not to do this. Instead I hope that the analysis of my recordings coupled with analysis of each work and access to the click tracks will prove to be a useful resource for students and other musicians who wish to study this music. I also acknowledge the fact that 'time' and timing is an ever-changing performance parameter and that, as a consequence, the click tracks themselves are slightly flawed. A performer may bend 'time' in some areas and adjust accordingly to 'get back in time' – something that a click track does not accommodate for. However, the click tracks will still assist in demonstrating whether or not the performer executes the modulations and rhythms correctly and in addition to the analysis provided, create a strong collection of results that can be used to determine their effectiveness.

[4] Latham, Alison. "metre." *The Oxford Companion to Music*. *Oxford Music Online*. Oxford University Press, accessed August 12, 2013,http://www.oxfordmusiconline.com.ezproxy.ecu.edu.au/subscriber/article/opr/t114/e4387.

Chapter 1

Elliott Carter – A Biography

Elliott Cook Carter Jr. (1908 – 2012) grew up in West Manhattan and appeared destined to follow in his father's footsteps – from a young age he "was groomed for the third generation of lace importing"[5], a business that his grandfather began after the Civil War. His father did not consider music and in particular, composition, to be a valuable use one's time. Despite this, Carter was determined to study music and begged his parents for piano lessons as a child.

Carter's interest in music as an art form became apparent in his high school years. His first major musical influence was that of his tutor, Clifton Furness, with whom he studied at the Horace Mann School from 1920 – 1926. Furness recognised Carter's talent and encouraged his interest in music, taking "him to avant-garde concerts in Greenwich Village and…introduce(ing) him to Charles Ives"[6] in 1924. Ives (1874 – 1954, USA) would become another significant influence on Carter and his compositional style.

Once he had graduated from high school, Carter attended Harvard and after being "put off by the conservatism of the music professors, (he) studied English, philosophy, mathematics and classics."[7] However, during his later years as a student at Harvard Carter had the opportunity to study composition with Gustav Holst (1874 – 1934, Britain), who was a visiting tutor at the school for one year. "Holst was slightly distressed by Carter's efforts, in both composition and piano playing, and considered that if the young man did not make so many mistakes while trying to play Beethoven he might perhaps not write so many mistakes into his own work"[8]. After this eye-opening experience and encouragement from Walter Piston, another member of staff at the school, Carter decided to pursue music composition seriously.

> "In 1932, after completing his master's degree, Mr. Carter went to Paris for three years of study with Nadia Boulanger, both privately and at the École Normale de Musique. While in Paris in 1933, he was commissioned to write incidental music for a production of Sophocles' "Philoctetes" at the Harvard Classical Club. The work was his first to be performed in public."[9]

After completing his studies in Paris, Carter returned to the USA in 1935. In his first few years after studying Carter made a living as a performing pianist, vocalist and oboist, although he found no joy in performing and stopped whenever he could afford to. Carter also gained a position as music director of Lincoln Kirstein's Ballet Caravan, for which he wrote the ballet "Pocahontas" (1939), a work with echoes of Stravinsky's "Rite of Spring"[10], as well as getting married to his wife, Helen Frost- Jones, in 1939 (their only child, David, was born in 1943). Although Carter had achieved some success, he began to question his compositional identity – "By the mid-1940s Mr. Carter had won several prizes but had made little headway with the public, and he began to regard his consonant style as an unrewarding compromise"[11]. With this realisation came a change in compositional style and a new direction to Carter's compositional career.

---

[5] D. Schiff, *The Music of Elliott Carter* (CORNELL University Press, 1998).14
[6] D. Schiff, *The Music of Elliott Carter*. 14
[7] D. Schiff, *The Music of Elliott Carter*. 16
[8] Goldman, "The Music of Elliott Carter."153
[9] Allan Kozin, "Elliott Carter, Composer Who Decisively Snapped Tradition, Dies at 103," *New Work Times*, November 6, 2012 2012.
[10] Allan Kozin, "Elliott Carter, Composer Who Decisively Snapped Tradition, Dies at 103,"
[11] Allan Kozin, "Elliott Carter, Composer Who Decisively Snapped Tradition, Dies at 103,"

By the late 1940's, Carter's compositional direction had taken a different path, one which eventually led to his fascination with 'time' and his development of what has become known as 'metric modulation'. Carter has discussed this period, in which he spent a year living and composing in southern Arizona:

> "One of the aspects of my period, in my life, was the notion of the experience of time. Of course, it's a very old idea, people have been working on time since Adam and Eve, I expect. But the idea of treating time as a very vivid and strong thing is certainly very important in Marcel Proust and James Joyce. Those were writers I read when I was too young to read such nasty pieces, but in any case this has been something that is very important to me. I have tried in my pieces to give the concept of the passage of time as a dramatic idea, so that the pieces change as they go along in one way or another; different kinds of rhythm conflict with each other and so on. This was a sense that I wanted to give because after all, as we live our own lives, we are constantly involved in all sorts of different aspects of time."[12]

As a consequence of this compositional shift, Carter's works began to be "driven by the tension between independent and starkly contrasting elements"[13] and were experimenting with constantly changing and opposing time and time systems. He continued to develop his own compositional style, becoming dissatisfied with the music of his previous influences. One such influence was Charles Ives, with whom Carter's relationship had strained since the mid 1930's. "Ives's innovations… for all the initial excitement they provoked, eventually appeared to him deeply problematic"[14]. Carter began to view Ives' music as confused and muddled and sought a more effective way to experiment with rhythmic manipulation in his works. Other influences on Carter during this period included Henry Cowell (1897 – 1963, USA) and Conlon Nancarrow (1912 – 1997, USA). Carter's views on 'time' in music were affirmed by these composers for, in his opinion, "all three (composers') approaches to rhythmic emancipation proved, in one way or another, unsatisfactory"[15]. Carter continued this compositional path for a number of years, producing works such as his *Second String Quartet* (1959) and his *Double Concerto* (1961).

After this period of change in Carter's career he gained more popularity and success with the public and was awarded two Pulitzer Prizes (the first in 1960 and the second in 1973). Carter earned many other awards throughout the remainder of his career and also enjoyed a career as an educator, holding positions at Peabody Conservatory (1946–1948), Columbia University, Queens College, New York (1955–56), Yale University (1960–62), Cornell University (from 1967) and the Juilliard School (from 1972). He maintained a prolific rate of composition until his death, publishing more than 40 works between the ages of 90 – 100 and at least 14 more up until his death at the age of 103.

[12] Sue Knussen and Elliott Carter, "Elliott Carter in Interview," *Tempo*, no. 197 (1996).5
[13] Allan Kozin, "Elliott Carter, Composer Who Decisively Snapped Tradition, Dies at 103,"
[14] Jonathan W. Bernard, "The Evolution of Elliott Carter's Rhythmic Practice," *Perspectives of New Music* 26, no. 2 (1988).165
[15] Jonathan W. Bernard, "The Evolution of Elliott Carter's Rhythmic Practice,". 165

Carter's Compositional Style and Development

Elliott Carter's compositional style and musical views changed a great deal throughout his career. His "music *is* complex…but it has never been music *about* complexity."[16] However, the modernist-style compositions and boundary- pushing writing Carter became known for is not how he began his career as a composer.

As a consequence of studying with Boulanger in Paris, Carter's initial works were strongly influenced be her. They were very traditional compared to his later works and were consonant and conservative in nature – they did little to push the boundaries of composition. "Boulanger's impact on Carter's composing (was) evident, perhaps negatively, in the works he wrote in the decade after he left Paris, which show no traces of the ultra-modernist music he admired in the 1920s"[17]. Carter appeared to attempt to break away from this style with his ballet *Pocahontas* (1936), which was written in a more Modernist style but achieved little success. Instead Carter became influenced by Aaron Copland (1900 – 1990, USA) and his "simplicity and American quality"[18]. This compositional style is evident in his works *Holiday Overture* (1944) and *First Symphony* (1942). However, it was in Carter's *Piano Sonata* (1945 – 1946) that he showed signs that his compositional identity was evolving – "for the first time Carter revealed the dramatic scale and sweep that came to characterize many of his later works"[19].

This gradual development into Carter's 'mature' compositional style came to the fore in two works – his *Cello Sonata* (1948) and his *String Quartet* (1950 -1951), the latter of which was composed during his year in the desert in Arizona and his subsequent change in compositional direction.

> "This (the cello) sonata may well be one of the influential works of the century, for in it Carter used for the first time a principle that he had been developing for some time. This principle has been described as "metrical modulation".[20]
>
> "This work (*String Quartet*) is almost without doubt the most important and imposing accomplishment of American music in the last decade. It involves a texture in which non-simultaneous changes of speed ("metrical modulations") in the four instruments become the essence of the contrapuntal texture"[21].

An example of the development and use of metric modulation in Carter's *String Quartet* and *Cello Sonata* can be seen in Figure 1 and Figure 2 respectively.

[16] J. Wierzbicki, *Elliott Carter* (University of Illinois Press, 2011).1
[17] David Schiff. "Carter, Elliott." *Grove Music Online*. *Oxford Music Online*. Oxford University Press, accessed September 25, 2013,http://www.oxfordmusiconline.com.ezproxy.ecu.edu.au/subscriber/article/grove/music/05030.
[18] David Schiff. "Carter, Elliott." *Grove Music Online*. *Oxford Music Online*
[19] David Schiff. "Carter, Elliott." *Grove Music Online*. *Oxford Music Online*
[20] Goldman, "The Music of Elliott Carter."162
[21] Ibid.162

Figure 1. The first movement of Elliott Carter's first String Quartet (1950 – 1951), bars 36 – 43.

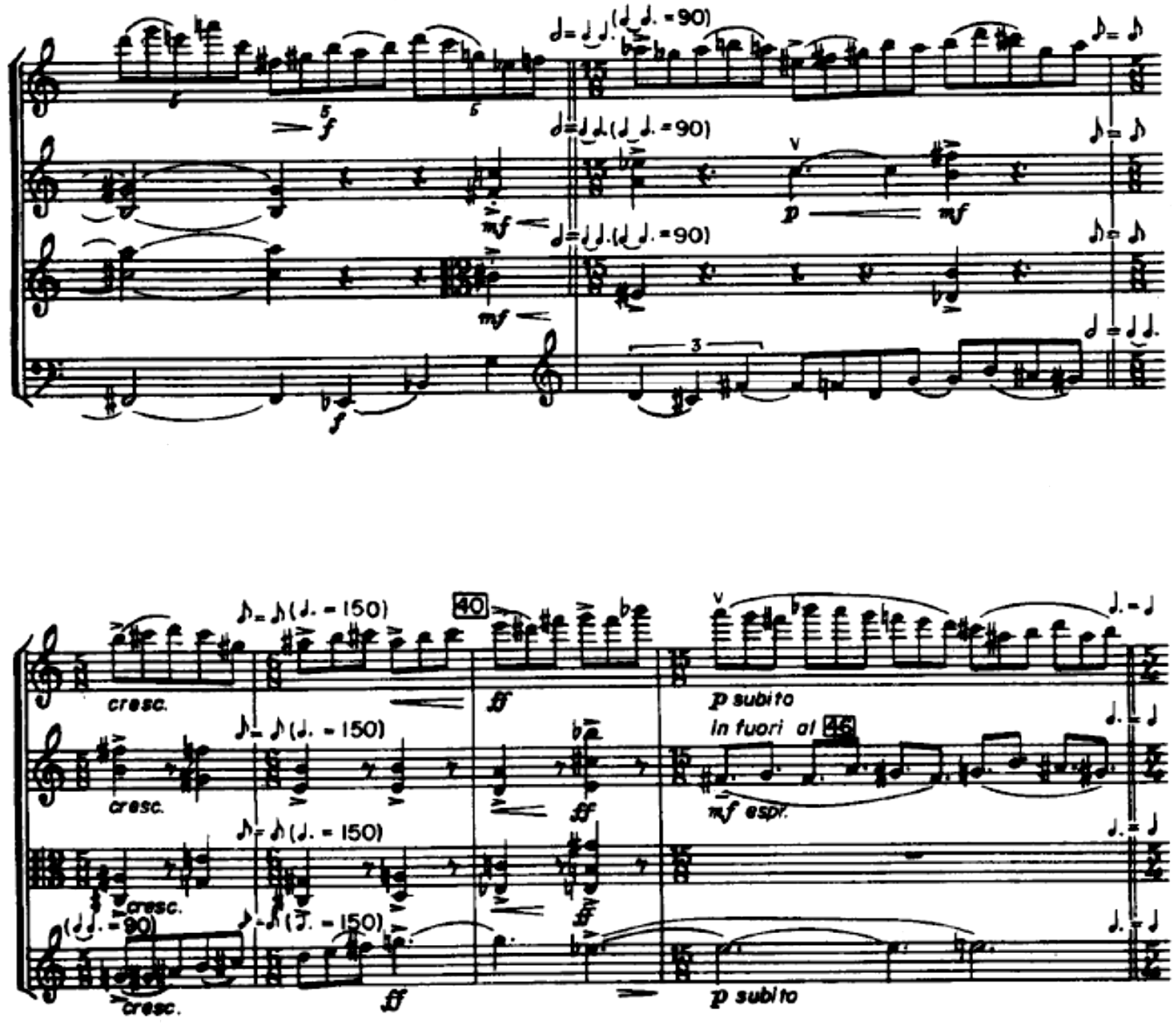
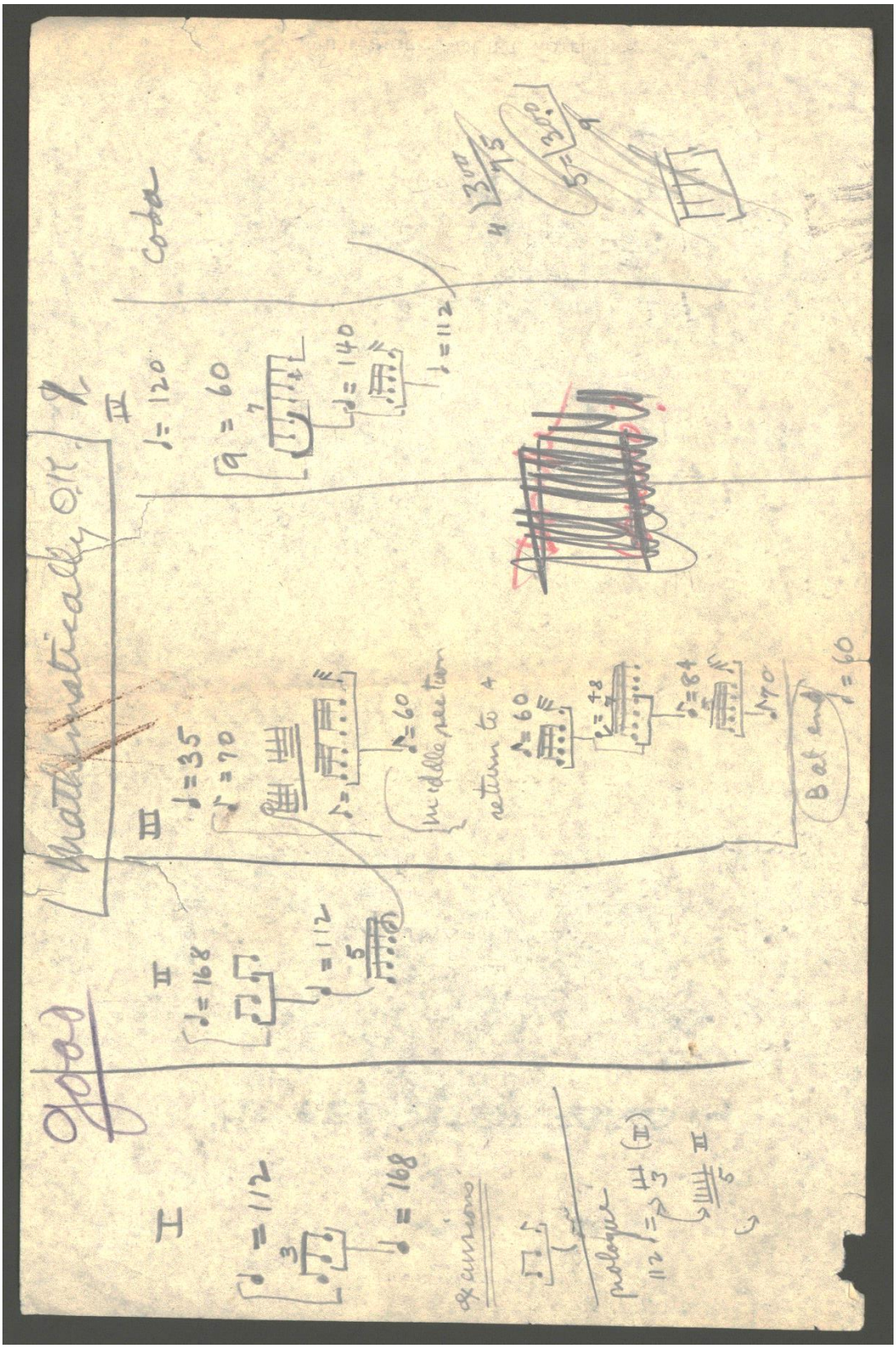


Figure 2. Digitized copy of original sketches of the mathematical processes involved in metric modulation in Carter's Cello Sonata



In these works, as well as in others of this period, Carter explored the possibility of manipulating 'time' through metric modulation and began to develop the technique now known as 'temporal modulation'. Concerning his fascination with the technique, Carter has said:

> "The effect that I am interested in producing is…one of perceived large-scale rhythmic tension, sometimes involving the anticipation of an impending final coincidence of all the disparate rhythmic layers at some key moment… [O]ne of the things that I like about this kind of effect [temporal modulation] at slow speed is that at first these points of rhythm don't seem to have any graspable relation to each other and appear perplexing or perhaps chaotic…Then, as these beats begin to converge toward a unison, you begin to become aware of their pattern and to grasp the emerging rhythmic convergences. Conversely, the rhythm may at first appear clearly directional and structured and then seem to disintegrate into a floating, apparent incoherence. This sense of progression into extreme irregularity and back to a perceptible order appears in many of my works." [22]

It was during this period that Carter also began to compose his *Eight Pieces for Four Timpani* (1950 – 1966), in which these techniques are present. Although Carter played a pivotal role in developing these techniques, he himself has acknowledged that he didn't invent them but rather modified and effectively employed them in his compositions. He discovered the potential for these processes by examining fourteenth and fifteenth century music. Works by Carter's predecessors also show signs of these techniques:

> (Stravinsky) used three tempos (M.M.72, 108 and 144) in a ratio of 2:3:4 in his Symphonies d'instruments à vent. In Carter's First Quartet, however, the scale of tempos is larger, their ratios are more complex, and, most importantly, changes in notated tempo often happen within rather than between phrases.[23]

Carter further explored metric modulation and manipulating 'time' in his *Variations for Orchestra* (1954 – 1955). This work achieved a great deal of success and cemented Carter's new compositional identity and his reputation as a composer of complex, Modernist music. However, by the 1960's Carter's style was once again evolving.

Carter's compositional evolution became evident in his *Second String Quartet* (1959) and was affirmed in his *Double Concerto for Harpsichord and Piano* (1961). He became influenced by Pierre Boulez (1925 – present, France) and the European avante garde composers. "He abandoned the long phrases and cumulative textures of the First Quartet and pursued a more fragmented, unpredictable and dissonant style which nonetheless retains many elements of American ultramodernism."[24] This newly emerging style is illustrated in an excerpt from the *Double Concerto* in Figure 3. These works also demonstrate a new found interest in space and "introduced structural ideas that became fundamental to all Carter's later music: the contrapuntal partitioning of harmonic intervals, the use of recurring all-interval chords which unite the opposed harmonies, and systematic contrasts of tempo framed by large-scale polyrhythmic designs"[25]. During the remainder of this period in Carter's career he continued to explore these ideas in works such as his *Concerto for Orchestra* (1969).With these works Carter truly began to break away from the influence of other composers and establish his own compositional niche.

---

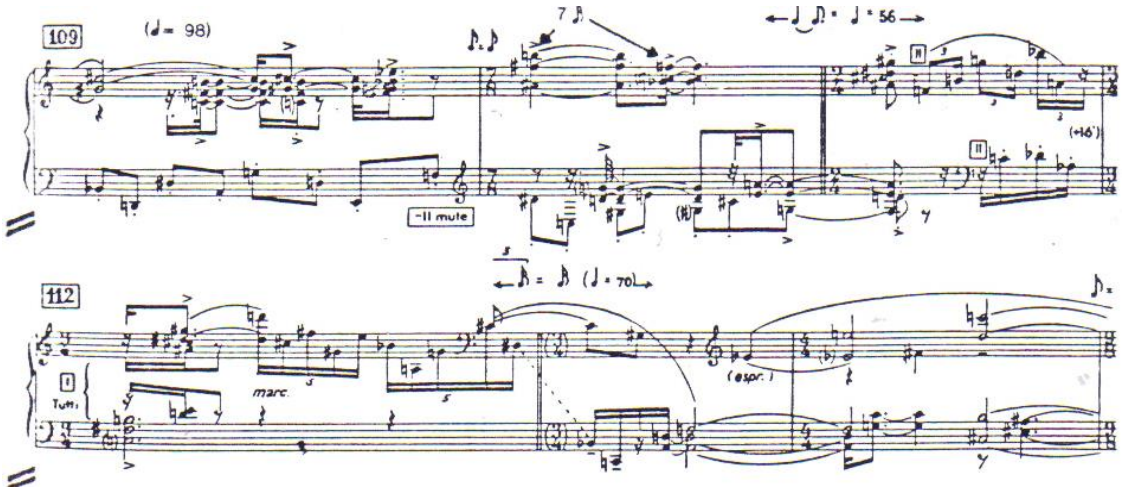
[22] Amanda Fawcett-Lothson, "Elliott Carter's New Approach to the Ancient Practice of Temporal Modulation" (M.M., Northern Illinois University, 2012).

[23] David Schiff. "Carter, Elliott." *Grove Music Online*. *Oxford Music Online*. Oxford University Press, accessed May 12, 2013,http://www.oxfordmusiconline.com.ezproxy.ecu.edu.au/subscriber/article/grove/music/05030.

[24] David Schiff. "Carter, Elliott." *Grove Music Online*. *Oxford Music Online*

[25] David Schiff. "Carter, Elliott." *Grove Music Online*. *Oxford Music Online*

Figure 3. An example of Carter's changing musical style, evident in his Double Concerto for Harpsichord and Piano (1961).



Towards the latter part of his career, Carter's musical identity again experienced a shift. After a long period in which he avoided composing opera and vocal works, he returned to the vocal genre in the 1970s. Furthermore, Carter no longer published long works which took a considerable amount of time to write but rather produced a number of shorter, more fluid works. During this period Carter seemed to make peace with music as an art form – "many of his late works resolve opposition into unity and dark textures into luminous ones."[26] His music experienced a process of 'simplification' – "fluency and simplification of polyrhythm (is present) in his recent music"[27] and his harmonies are less atonal - works contained more recognisable beauty and less dissonant opposition between instruments and textures. However, this doesn't mark a return to his initial compositional style but rather "a post-modern dialogue with 'classicism'"[28]. After avoiding opera for his career to date, Carter completed his first one, *What Next?* in 1998, at the age of 90.

Although Carter's compositional identity morphed throughout his career, his music always maintained some important core characteristics and he always held strong opinions as a composer. Carter's music was typically "harmonically brash and melodically sharp-edged on the first hearing, but (it) often yielded drama and lyricism on better acquaintance"[29]. His music always contained a certain level of complexity and even in his early years, "trained musicians sometimes regarded his constructions as too difficult to grasp without intensive study"[30]. As a composer, Carter preferred 'new music' and always sought to discover new compositional techniques, even if it did take time in the initial stages of his career to find his own identity. Throughout his career, "every piece that once seemed to be the capstone (of Carter's illustrious career) has turned out instead to be a milestone that marks the beginning of another path."[31] He enjoyed a long and successful career in which he contributed to the development of metric and temporal modulation and other musical concepts, and his works influenced other composers of the twentieth century and beyond.

[26] David Schiff. "Carter, Elliott." *Grove Music Online*. *Oxford Music Online*
[27] Antony Bye, "Carter's 'Classic' Modernism," *Tempo*, no. 189 (1994).3
[28] Antony Bye, "Carter's 'Classic' Modernism,".3
[29] Allan Kozin, "Elliott Carter, Composer Who Decisively Snapped Tradition, Dies at 103,"
[30] Allan Kozin, "Elliott Carter, Composer Who Decisively Snapped Tradition, Dies at 103,"
[31] John Link, "Elliott Carter's 'Late Music'?," *Tempo* 62, no. 246 (2008).1

Chapter 2

Eight Pieces for Four Timpani - A History

Overview

Elliott Carter's *Eight Pieces for Four Timpani* were written between 1950 – 1966, undergoing various revisions and additions during this period. The pieces were composed "as compositional studies mainly in tempo modulation"[32] and were also amongst the first timpani pieces to experiment with timbral manipulation on the instrument. In each piece "different types of sticks (are) required (and) there are also specific directions on where…to strike on the head, type of stroke, amount of resonance to be allowed, harmonics, etc."[33]

Carter initially composed a set of six pieces rather than eight – the *Six Pieces for Four Kettledrums*, with the intention that they be used "as rhythmic studies for the composer's String Quartet #1"[34]. Upon completing these works, Carter showed them to several percussionists in New York and was very dissatisfied with the way they sounded. Consequently, only two pieces (*Improvisation* and *Recitative*) were published in 1960, with the rest existing in manuscript only although copies of the originals became widely distributed and studied. The initial versions of the six pieces contained none of the extended techniques and additional technical challenges that are present in the revised editions.

On May 9th, 1965 Carter attended an "'Evenings for New Music' (concert) regularly presented… at the Albright-Knox Art Gallery in Buffalo and Carnegie Hall in New York City"[35], in which notable percussion soloist and conductor, Jan Williams (1939 – present, USA) performed *Recitative*, *Moto Perpetuo* and *Improvisation*. Carter met with Williams and expressed an interest in revising his *Six Pieces for Four Kettledrums*, given that "the published editions of *Recitative* and *Improvisation* would soon expire"[36]. As a result of this meeting, the two began working together on revising these works.

"One of the first questions that arose concerned the different sounds obtained relative to where the drum was struck"[37]. After much experimentation, three basic striking areas were determined – the normal area (notated with an 'N'), the centre of the drum ('C') and the rim of the drum ('R'), with each area producing its own distinct sound characteristics. Carter included instructions pertaining to striking area in the revised editions of the timpani works. These instructions can be seen in Figure 4. Other additions concerning sound production included instructions to play with the butt ends of mallets, perform harmonics on the drums and execute a variety of strokes, including dead and muted strokes. A number of structural/ note changes were also made in a few of the works.

Figure 5 contains musical samples of the original version of *Improvisation* compared to the revised version of the work.

Throughout the process of revising the *Six Pieces for Four Kettledrums*, Carter decided to write two new pieces "utilizing extensive pitch changes"[38], thus forming the *Eight Piece for Four Timpani*. *Canto* and *Adagio* are the only two pieces in the collection that employ pedalling, both through 'direct shifts' (a clean, purposeful movement of the pedal to change from one absolute pitch to another on the same drum) and through the use of glissandi and pitch bending.

---

[32] Schiff, *The Music of Elliott Carter*.148
[33] Albert Seay, *Notes* 26, no. 3 (1970).625
[34] Jan Williams, "Elliott Carter's "Eight Pieces for Four Timpani" - the 1966 Revisions," *Percussive Notes* 6, no. 38 (2000).8
[35] Jan Williams, "Elliott Carter's "Eight Pieces for Four Timpani" - the 1966 Revisions,"8
[36] Jan Williams, "Elliott Carter's "Eight Pieces for Four Timpani" - the 1966 Revisions,"8
[37] Jan Williams, "Elliott Carter's "Eight Pieces for Four Timpani" - the 1966 Revisions,"9
[38] Jan Williams, "Elliott Carter's "Eight Pieces for Four Timpani" - the 1966 Revisions,"9

Figure 4. Carter's instructions concerning striking area etc. in the revised edition of his Eight Pieces for Four Timpani.

Performance Notes

1. *Public performance:* The printing order of these eight pieces was chosen largely to facilitate page turns, hence this order is not meant to suggest the order of performance. The group of eight is a collection of pieces from which not more than four are ever to be played as a suite in public. The order of these should be chosen to produce the maximum of variety, possibly according to the following suggestions:
   (a) If pedal timpani are available, III and/or VI may be included.
   (b) IV, V, VII and VIII can be used as beginning or ending pieces, while I, II, III and VI can be performed between them.
   (c) When played in sequence, it is important that not more than one pitch be carried over from one piece to the next — hence some may be transposed.

2. *Timpani:* Although all eight pieces can be performed on four standardized drums — 30″, 28″, 25″ and 23″ — other sized drums can be used to favor the effect of certain pieces. Although pedal timpani are required for III and VI, their use is not essential for the other pieces. However, pedal timpani can be useful for quick tuning changes between pieces for public performance.

3. *Sticks:* Sticks for I, III, IV, V and VII should be chosen to bring out the character of each piece. In VIII, medium-hard sticks are suggested; in VI, wooden snare drum sticks. In II, special rattan sticks with cloth (corduroy)-covered tips produce the best effect (see Example 1). IV uses a soft bass drum stick for its final note. I and VIII call for the reversing of the timpani sticks to strike with the wooden handles or butts. The striking with the wood is indicated BUTT, and the usual way of striking is indicated HEAD

4. *Stick strokes:* Unless otherwise specified, the usual type of stroke is to be used. This "normal stroke" is indicated by the sign NS when used to cancel the "dead stroke" DS — as in II, IV, and at the end of I. A "dead stroke" is one in which the head of the stick is held down on the drum after striking to damp all resonance at once.
   The appearance of the small sign , found in all of the pieces except VI, indicates *hand damping.*
   In VI, the sign means *on the rim* (not on the drum head), and the sign means *rim shot.*

5. *Striking positions on the drum head:* To produce a wide variety of different sound qualities, various striking positions are suggested. They are notated as follows:

   Normal striking position on head
   Striking at center of head
   Striking on head very near the rim
   (see Example 2)
   Change gradually from normal position to center of head

   Each of these positions should produce a distinctly different sound. Where nothing is suggested, the choice of striking positions is left to the discretion of the player.

6. *Special effects:*
   II: In the use of the cloth-covered rattan sticks, two types of striking are indicated (see Example 1):

   Tp — Striking with the tip
   Hd — Striking with the head

4a.

Example 2 Striking Positions on Drum Head

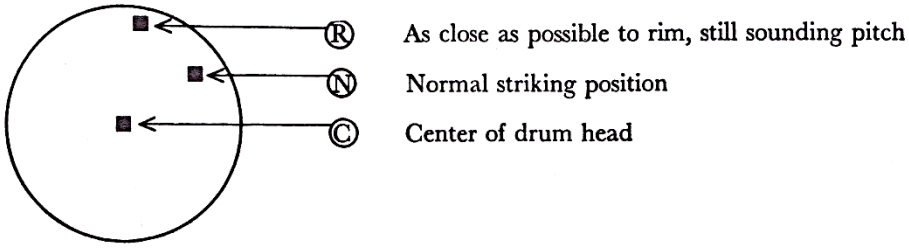


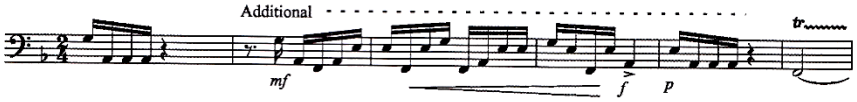
Figure 5. A comparison of a section of original version of Improvisation with the revised edition of the piece

I. Improvisation

The *Original* examples are transposed to the *1968* key.

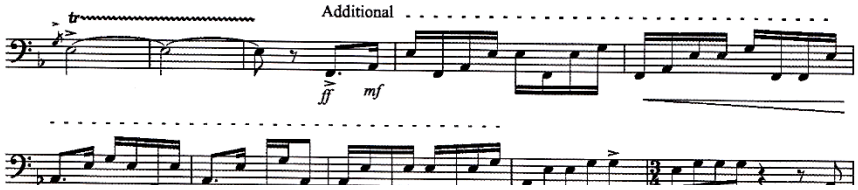
Page14, line 6, measure 2: There are four additional measures.

Original



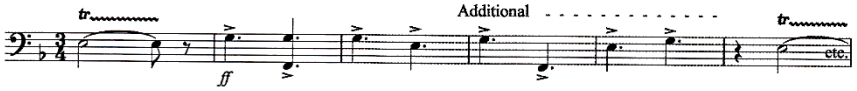
Page 14, line 8: The phrase has been rewritten.

Original



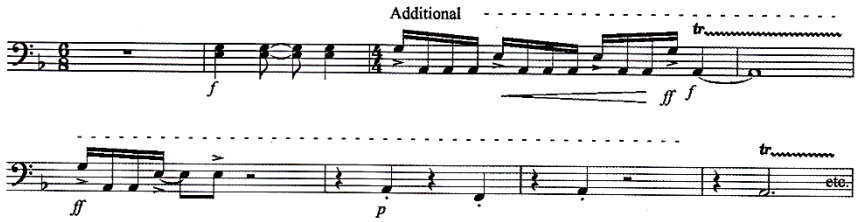
Page 15, line 2, measure 4: There are two additional measures.

Original



Page 15, line 5: The phrase has been rewritten.

Original



The complete set of eight pieces (including revisions) was published in 1968 and are "an anthology, not a suite; and the composer…specifies that no more than four of them should be played as a suite in public."[39] Since being published as a set, the works enjoyed increasing success and gradually cemented themselves as pivotal works in the genre of solo timpani. "The *Eight Pieces* are a tour de force for a medium that is all too often afflicted with a repertory that shows little more than manual dexterity…(they are) virtuoso studies for the timpanist, as well as a concentrated treatise on what can be done with available resources."[40]

Saeta

Saeta is the first piece in the *Eight Pieces for Four Timpani*. On this piece, Carter wrote:

"An Andalusian song of improvisationary character sung during an outdoor religious procession….said to be the descendant of a rain ceremony during which the arrow (saeta) was shot into the clouds to release the rain."[41]

The piece opens with a dramatic free time bar, followed by the presentation of two intertwining musical lines (one in the left hand and one in the right), which are manipulated throughout the piece due to the metric modulations present (such as in bars 21 – 26). "Saeta is both improvisationary and ritualistic in character".[42] The piece also contains several extended techniques, including playing with the butt ends of the mallets and making use of the various striking positions indicated to timbrally differentiate between musical lines. *Saeta* is dedicated to Al Howard.

Moto Perpetuo

Meaning "perpetual motion", *Moto Perpetuo* is one of three pieces in the set that does not contain metric or temporal modulation. This piece requires custom-made mallets that enable the performer to rapidly change from the cloth head of a mallet to a wooden surface, typically the butts (this piece is too fast and constant to make the change to butt ends). Throughout the piece a constant, static tempo is maintained, although changing groupings gives the piece shape and direction. "The tone colour changes with the accentuation as the drums are struck in different places… the overall effect is of a sustained sound rapidly flickering in colour."[43] This piece is dedicated to percussionist and educator, Paul Price.

Adagio

Adagio was one of the pieces that was newly composed whilst Carter and Williams were revising the *Six Pieces for four Kettledrums* and is one of only two of the works that contain pedalling in the *Eight Pieces for Four Timpani*. The pedals are used to perform glissandi, vibratos, harmonics and sympathetic vibrations. When writing about this work, Jan Williams said:

""Adagio" is probably the most abstract of the eight pieces, but I think it is one of the most beautiful timpani pieces in the repertoire."[44]

This piece is dedicated to Jan Williams.

---

[39]Schiff, *The Music of Elliott Carter*. 148
[40]Seay.625
[41] Schiff, *The Music of Elliott Carter*.148
[42] Ibid.
[43] Ibid.
[44] Jan Williams, "Elliott Carter's "Eight Pieces for Four Timpani" - the 1966 Revisions,"12

Recitative

"This piece contrasts three ideas whose independent developments are cross-cut: a dramatic tremolo, a bolero rhythm, and an irregular heart-murmur pulse."[45] Along with 'Improvisation', *Recitative* was part of the pair of pieces that were initially published. This piece contains a great deal of rhythmic detail, more so than any of the other eight pieces, thus requiring a hard mallet to be used during performance to maximise rhythmic clarity. It opens with a dramatic tremolo, showcasing the brilliance and authority of the timpani. This work is dedicated to Morris Lang.

Improvisation

Also dedicated to Paul Price, *Improvisation* is "a study in tempo modulation and free continuity."[46] Improvisationary- sounding sections are juxtaposed with strict rhythmic segments throughout this piece. The use of temporal modulation creates the illusion of tempo change due to improvisation. Like the other pieces in the *Eight Pieces for Four Timpani*, specific instructions relating to playing area have been included.

Canto

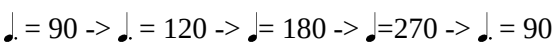
Canto is the other work that was composed in 1966 during the revision of the six original works and is primarily a 'free time' work (it is unique in this way in this collection.) It contains no metric or temporal modulation but does employ pedalling almost constantly throughout the entire piece, giving it a different timbral identity to the other seven pieces. On this piece, Carter has written:

> "('Canto' contains) a kind of glissando melody that is interrupted by bits of recitative. The melodic idea interested me the most." [47]

This piece is also intended to be played with drum sticks rather than timpani mallets, adding to its difference in timbre. This was a choice made by Carter and Williams after much deliberation during the composition of the work. This piece is dedicated to Jan Williams.

Canaries

Canaries was originally entitled "Canary", the title being a reference to a Baroque dance "imported from the 'wild men' of the Canary Islands – and not the chirping birds, although the pun is probably intended."[48] The piece contains a great deal of metric and temporal modulation, including a 'circle of modulation' present on the first page, in which Carter employs temporal modulation to shift through the following tempo cycle:



This occurs between bars 1 – 25. This piece is intended to prepare musicians for the jig-like rhythms present in Carter's 'First Quartet' and 'Harpsichord Sonata'. It is among the more popular and commonly performed works in the *Eight Pieces for four Timpani* and is dedicated to Raymond Des Roches.

[45] Schiff, *The Music of Elliott Carter*.149
[46] Ibid.
[47] Jan Williams, "Elliott Carter's "Eight Pieces for Four Timpani" - the 1966 Revisions,"12
[48] Schiff, *The Music of Elliott Carter*.150

March

March is the final piece in the set and is also one of the most commonly performed. The piece "contains two marches, each at its own speed, one played with the heads of the sticks, the other with the butts."[49] This constant change between heads and butts not only creates a diverse sound world throughout the piece but also gives the performance an interesting aesthetic property, as the performer navigates the constant change between mallet ends. The overall structure of the piece suggests a 'drum battle' or sorts between two marching snare drummers – the drummers "meet and 'challenge' each other, imitating each other's figures and outdoing one another in virtuosity… (before they) march away at different speeds."[50] *March* contains great groove and has a melodic quality to it, perhaps more so than the other works. It is dedicated to accomplished timpanist, Saul Goodman (1907 – 1996, USA).

[49] Ibid.151
[50] Ibid.151

Chapter 3

An Analysis of the *Eight Pieces for Four Timpani*

Introduction/ Explanation of Data Presentation

This chapter contains analysis of the modulations present in the five of Carter's *Eight Pieces for Four Timpani* that contain them (*Saeta*, *Recitative*, *Improvisation*, *Canaries* and *March*), be they metric or temporal. This analysis is represented in a table (separate for each piece). The more complex modulations in each work will be discussed in this chapter, as will any other important rhythmic characteristics present in them. The tables are structured as seen in Figure 6:

Figure 6. Structure of the table used to present analysis data for Carter's Eight Pieces for Four Timpani

Piece								**Initial Tempo:**
Mod. No.	**Method**	**Bar**	**Time Signature**	**Pulse Tempo**	**Sub. per Pulse**	**Subdivision Tempo**	**Tempo Relation**	**Musical Example**

Each modulation is referenced both by number (in which they occur) and bar number/s in the table. The column labelled "Method" will contain information regarding whether the modulation is performed through a common subdivision tempo (CST) or through a common pulse tempo (CPT). Whether or not the modulation has been prepared in the music leading up to it will also be indicated here. The column labelled "Subdivision Tempo" will contain the subdivision type and tempo used in that section of the modulation. If the modulation is achieved through CST, this information will be written in red and if it is achieved through CPT, it will be in blue, allowing for instant recognition of which musical parameter is kept constant throughout the modulation. The "Tempo Relation" column will provide a ratio of the initial tempo and consequent tempo, with the initial tempo always represented by the number on the left side of the ratio.

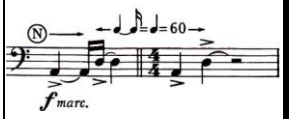
Saeta

The table containing the analysis of the modulations present in *Saeta* is shown in Figure 11.

Saeta contains seven modulations in total, varying in type and preparation. In the first section of the piece (bars 2 – 24), Carter manipulates the rhythm of the two intertwining musical lines through the constant alteration of quaver groupings, shifting the theme and creating the illusion of fluid but fluctuating time. This theme is only briefly interrupted by a 'free time' segment in bars 6 – 7. By experimenting with the grouping of quavers in this section Carter also creates an unstable pulse, which never maintains a constant tempo between bars. Although it may appear that this section contains modulations (the subdivision tempo remains constant and could therefore be considered the link between sections in a modulation), a new meter and consequent new time system are never truly established – the pattern of subdivisions and pulses doesn't remain the same for a long enough period of time to be considered a new time system. Instead, this section can simply be seen as an experimentation with shifting pulse through rhythmic manipulation.

The first modulation (Mod. 1) occurs throughout bars 25 – 26 and is an example of a 'prepared modulation', linked by a CST. An excerpt from the table presented is shown in Figure 7 below:

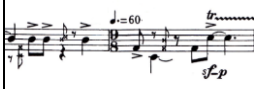
Figure 7. Excerpt from table of analysis of Saeta showing Mod. 1

Mod. No.	Method	Bar	Time Signature	Pulse Tempo	Sub. per Pulse	Subdivision Tempo	Tempo Relation	Musical Example
1	CST (prepared)	25	5/8	♪=150	2	♪=300	2:5	Bar:25 26 
		26	4/4	♩=60	5 (implied 2)	♪=300		

In order to perform this modulation correctly, the performer should take note of the quavers present throughout the previous section and make them the temporary 'pulse'. By doing so, the performer is able to accurately play the rhythm in bar 25 (which requires the performer to strike a drum between the 3rd and 4th quaver of the bar). The two notes played in bar 25 (on the 1st quaver and between the 3rd and 4th) should then be taken as the new pulse – they become the crotchet value in the next section.

Mod. 2 is linked through a CPT, meaning the pulse tempo remains the same. The table excerpt is shown in Figure 8

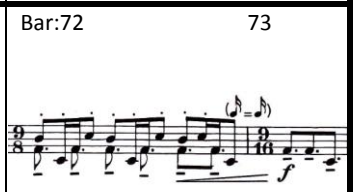
Figure 8. Excerpt from table of analysis of Saeta showing Mod. 2

Mod. No.	Method	Bar	Time Signature	Pulse Tempo	Sub. per Pulse	Subdivision Tempo	Tempo Relation	Musical Example
2	CPT (unprep.)	34	4/4	♩=60	2	♪=120	1:1	Bar:34 35 
		35	9/8	♩.=60	3	♪=180		

In order to perform this modulation, the performer should mentally alter the intended subdivision of quavers to quaver triplets in the last crotchet of the preceding bar (b. 34). Each quaver in the triplet becomes the quaver value in bar 35. The subdivision tempo is consequently increased by a third, causing a modulation to occur.

Mod. 6 (excerpt from table in Figure 9 can be executed correctly by shifting focus from the pulse in the previous bar to the subdivision, and then proceeding to subdivide this into semiquavers (split the subdivision in two). These semiquavers become the new subdivision in bar 73 (9/16), with the pulse placed on every 3rd semiquaver. Alternatively, the performer can shift their focus onto the accented dotted quaver 'A's played by the left hand, which act as a preparation. By maintaining the tempo of these dotted quavers, the performer is able to accurately execute this modulation.

Figure 9. Excerpt from table of analysis of Saeta showing Mod. 6

Mod. No.	Method	Bar	Time Signature	Pulse Tempo	Sub. per Pulse	Subdivision Tempo	Tempo Relation	Musical Example
6	CST (unprep.)	72	9/8	♩=75	3	𝅘𝅥𝅯=450 (𝅘𝅥𝅯=225)	2:1	
		73	9/16	♪.=150	3	𝅘𝅥𝅯=450		

Recitative

The table containing the analysis of the modulations present in *Recitative* is shown in Figure 12.

Despite the complex rhythmic nature of *Recitative* the piece only contains two modulations. In the music prior to Mod. 1, Carter employs a variety of tuplets, including a 'bolero' theme, first present in bars 8 – 9. Use of these tuplets creates a complex rhythmic environment through which the performer must navigate with precision and clarity, adhering to the strict nature of the piece, in order to produce an effective realisation of the work.

Mod. 1 and Mod. 2 are linked in this piece, with the successful performance of the second modulation depending on the accurate execution of the first. In order to perform Mod. 1 correctly, the performer needs to maintain a sense the demi-semiquavers in bar 28 (9/32), which remain constant throughout bar 29. The pulse shifts from every 9th demi-semiquaver to every 7th.

Mod. 2 is realised correctly by maintaining the pulse and altering the subdivision. In bar 30, this subdivision should considered as two per pulse (this subdivision is implied by the dampening indications in the 3rd beat (after the modulation has occurred), thus the label of 'antepared'.) Therefore, whilst the pulse remains, the subdivision changes from seven per pulse to two per pulse. These modulations can be seen in the table excerpt in Figure 10 below:

Figure 10. Table of analysis of Recitative showing all modulations

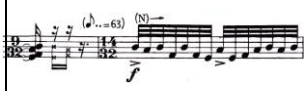
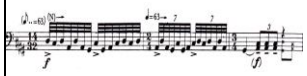
Piece	**Recitative**							**Initial Tempo:** ♩=49
Mod. No.	**Method**	**Bar**	**Time Signature**	**Pulse Tempo**	**Sub. per Pulse**	**Subdivision Tempo**	**Tempo Relation**	**Musical Example**
1	CST (prepared)	28	9/32	♩𝅘𝅥𝅯=49	9	𝅘𝅥𝅯=441	7:9	Bar:28 29 
		29	14/32	♪.=63	7	𝅘𝅥𝅯=441		
2	CPT (unprep.) (Antepared)	29	14/32	♪..=63	7	𝅘𝅥𝅯=441	1:1	Bar:29 30 31 
		30	2/4	♩=63	2 (implied)	♪=126		

Figure 11. Table containing the analysis of the modulations present in Saeta

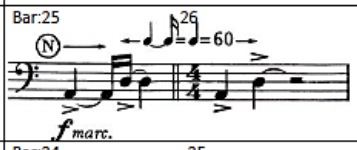
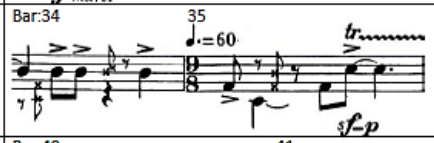
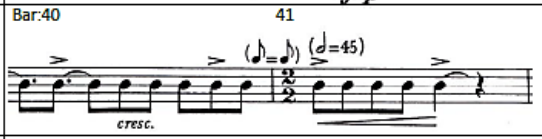
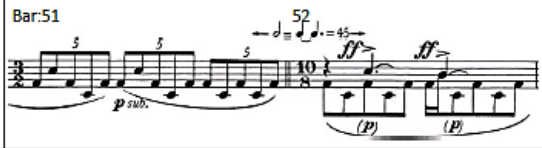
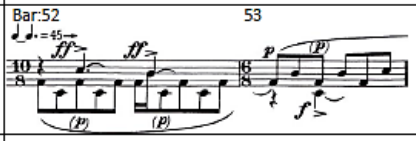
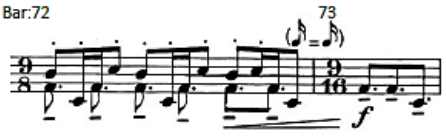
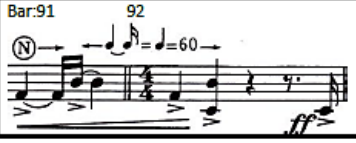
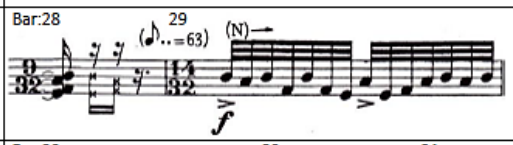
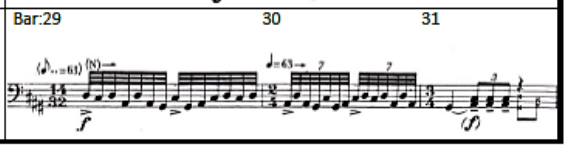
Piece	Saeta							Initial Tempo: ♩=50
Mod. No.	Method	Bar	Time Signature	Pulse Tempo	Sub. per Pulse	Subdivision Tempo	Tempo Relation	Musical Example
1	CST (prepared)	25	5/8	♪=150	2	♪=300	2:5	
		26	4/4	♩=60	5 (implied 2)	♪=300		
2	CPT (unprep.)	34	4/4	♩=60	2	♪=120	1:1	
		35	9/8	♩=60	3	♪=180		
3	CST (prepared)	40	9/9	♩=60	3	♪=180	4:3	
		41	2/2	𝅗𝅥=45	4	♪=180		
4	CPT (prepared)	51	3/2	𝅗𝅥=45	4 (implied 5)	♪=180 (♪=225)	1:1	
		52	10/8	♩.♩.=45	5	♪=225		
5	CST (unprep.)	52	10/8	♩.♩.=45	5	♪=225	3:5	
		53	6/8	♩=75	3	♪=225		
6	CST (unprep.)	72	9/8	♩=75	3	♪=450 (♪=225)	2:1	
		73	9/16	♪=150	3	♪=450		
7	CST (prepared)	91	5/8	♪=150	2	♪=300	2:5	
		92	4/4	♩=60	5 (implied 2)	♪=300		

Figure 12. Table containing the analysis of the modulations present in Recitative

Piece	Recitative							Initial Tempo: ♩=49
Mod. No.	Method	Bar	Time Signature	Pulse Tempo	Sub. per Pulse	Subdivision Tempo	Tempo Relation	Musical Example
1	CST (prepared)	28	9/32	♩.𝅘𝅥𝅯=49	9	𝅘𝅥𝅯=441	7:9	
		29	14/32	♪.=63	7	𝅘𝅥𝅯=441		
2	CPT (unprep.) (Antepared)	29	14/32	♪..=63	7	𝅘𝅥𝅯=441	1:1	
		30	2/4	♩=63	2 (implied)	♪=126		

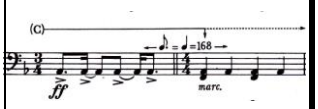
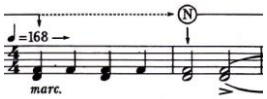
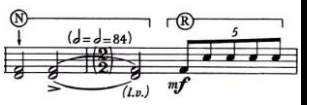
Improvisation

The table containing the analysis of the modulations present in *Improvisation* is shown in Figure 15.

Improvisation begins with three consecutive 'prepared' modulations, with each one set up through accurate realisation of the preceding modulation. As already mentioned, this piece uses temporal modulation to manipulate the tempo of the various sections of the piece, creating the illusion that these sections have been improvised. *Improvisation* is somewhat of a paradox – conforming strictly to the written rhythms throughout the work will result in a fluid, 'loose time' interpretation, as was the composer's intention. In addition to the nine modulations present, the piece also contains a rhythmic accelerando (bars 42 – 45), in which the performer must accurately play the tuplets for the desired effect to be achieved. The performer must also maintain a sense of pulse and count diligently throughout the rolls in bars 84 -94 in order to perform the rhythms surrounding them correctly.

The string of consecutive modulations that begins the piece is shown in the table excerpt in Figure 13 below:

Figure 13. Excerpt from table of analysis of Improvisation showing Mod. 1 - 3

Piece	**Improvisation**							**Initial Tempo:** ♩= 126
Mod. No.	**Method**	**Bar**	**Time Signature**	**Pulse Tempo**	**Sub. per Pulse**	**Subdivision Tempo**	**Tempo Relation**	**Musical Example**
1	CST (prepared)	15	3/4	♩= 126	4	♪=504	4:3	Bar:15 16 
		16	4/4	♩= 168	3 (implied)	$♪_3$=504		
2	CPT (prepared)	16	4/4	♩= 168	3 (implied)	$♪_3$=504	1:1 (2:1)	Bar:16 17 
		17	4/4 (implied 2/2)	♩=168 ♩=84	2 (implied)	♩= 168		
3	CPT (prepared) (implied)	17	4/4	♩=84	4	♪=336	1:1	Bar:17 18 
		18	2/2 (implied)	♩=84	5	$♪_5$=420		

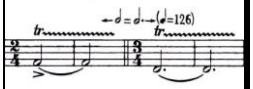
Mod. 1 is prepared and linked through a CST. The preparation is present in the form of an accented semiquaver rhythm in bar 15, which prevents the performer from playing on the downbeat of beats two and three, thus destabilising the pulse. Instead the performer is shifting the pulse from every 4th semiquaver (three pulses in the ¾ bar as is standard) to every 3rd semiquaver (four 'pulses' in the ¾ bar). These accented semiquavers become the new pulse in bar 16 (4/4).

Mod. 2 follows, occurring between bars 16 – 17. This modulation is linked through a CPT. The implied subdivision of three per pulse in bar 16 is altered in bar 17 to an implied subdivision of two per pulse (this implication is due to the following bars of music and Mod. 3). This alteration of subdivision leads to a new metre being established. This meter is only apparent for a short period but is considered established due to the fact that it must be present on order for Mod. 3 to occur.

Mod. 3 is also prepared – this preparation is implied by the use of minims in bar 17. During this modulation the CPT remains constant whilst the subdivision changes from two per pulse to five per pulse, which is then continued in the next section of the piece. The performer must carefully consider each modulation and maintain the common musical parameter in order to accurately perform this section.

Modulation 7 is one of the more complex modulations in *Improvisation* and can be achieved using various methods, of which two will be discussed. The segment of the table that presents the information pertaining to this modulation is shown in Figure 14 below:

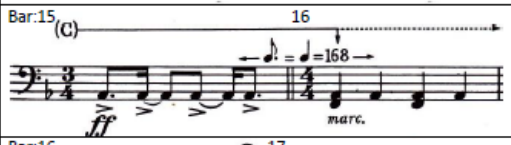
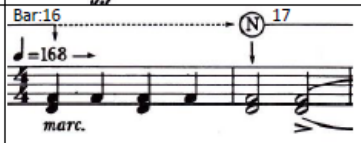
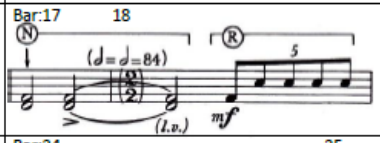
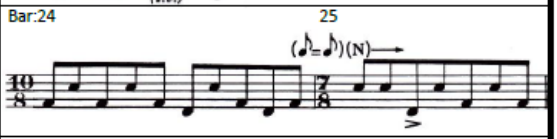
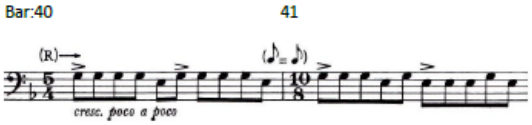
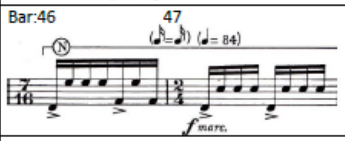
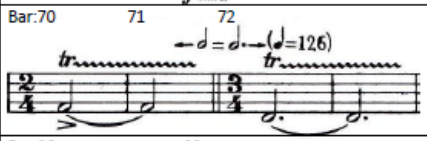
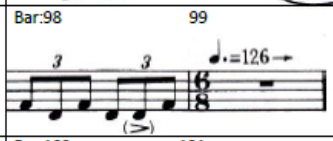
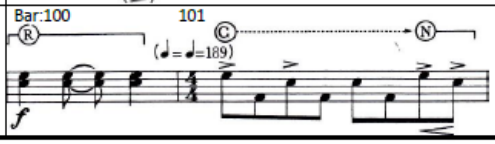
Figure 14. Excerpt from table of analysis of Improvisation showing Mod. 7

Mod. No.	Method	Bar	Time Signature	Pulse Tempo	Sub. per Pulse	Subdivision Tempo	Tempo Relation	Musical Example
7	CST (unprep.)	71	2/4	♩=84	3 (implied)	♪₃=252	3:2	Bar: 70 - 72 
		72	3/4	♩=126	2	♪=252		

The first of these methods involves the performer approaching these bars as having one pulse per bar, then shifting their mental approach to the subdivisions contained in these pulses. The performer should subdivide the pulse in bar 70 into quavers and then subdivides bar 72 into triplets, which become the new crotchet tempo from bar 72.

The second method involves mentally preparing a cross-rhythm in order to perform the modulation accurately. The performer should think of bar 70 as containing two crotchet pulses, which form one half a 2/3 cross-rhythm. The performer can then shift their focus from this side of the cross-rhythm to the other in bar 71, thus arriving at the new crotchet pulse by bar 72.

Figure 15. Table containing the analysis of the modulations present in Improvisation

Piece	Improvisation							Initial Tempo: ♩= 126
Mod. No.	Method	Bar	Time Signature	Pulse Tempo	Sub. per Pulse	Subdivision Tempo	Tempo Relation	Musical Example
1	CST (prepared)	15	3/4	♩= 126	4	♪=504	4:3	
		16	4/4	♩= 168	3 (implied)	♪3=504		
2	CPT (prepared)	16	4/4	♩= 168	3 (implied)	♪3=504	1:1 (2:1)	
		17	4/4 (implied 2/2)	♩=168 𝅗𝅥=84	2 (implied)	♩= 168		
3	CPT (prepared) (implied)	17	4/4	𝅗𝅥=84	4	♪=336	1:1	
		18	2/2 (implied)	𝅗𝅥=84	5	♪5=420		
4	CST (unprep.)	24	10/8	♩.♩.=84	5	♪=420	5:7	
		25	7/8	♩.♩.=60	7	♪=420		
5	CST (prepared)	40	5/4	♩=120	2	♪=240	2:5	
		41	10/8	♩.♪=48	5	♪=240		
6	CST (unprep.)	46	7/16	♩.=48	7	♪=336	7:4	
		47	2/4	♩=84	4	♪=336		
7	CST (unprep.)	71	2/4	♩=84	3 (implied)	♪3=252	3:2	
		72	3/4	♩=126	2	♪=252		
8	CPT (prepared)	98	2/4	♩=126	2 (implied)	♪=252	1:1	
		99	6/8	♩=126	3 (implied)	♪=378		
9	CST (prepared)	100	6/8	♩=126	3	♪=378	3:2	
		101	4/4	♩=189	2	♪=378		

Canaries

The table containing the analysis for *Canaries* is present in Figure 18.

Canaries contains 18 modulations in total, the most of any of Carter's *Eight Pieces for Four Timpani*. It also contains a number of complex rhythmic structures which may prove difficult for the performer to master. One such structure is present in bars 63 – 76, in which two pulses, "a constant (one) and an accelerating one are superimposed"[51]. The constant pulse is played in the left hand, between the lowest two drums, and provides a stable foundation against which the right hand can play the accelerating pulse on the top two drums. This 'dual pulse' also contains modulations and sets up Mod.15. The modulations present in this section may seem complex but if the performer is aware of the relationship between pulses and makes use of the accents written (which are intended to assist in maintaining the appropriate pulse tempo despite the rhythmic complexity) they will be able to perform the section accurately.

The ending section of *Canaries* can also prove to be a challenge for the performer. This section (which occurs from bar 118 – 136) does not contain any modulations, although this may not seem the case upon first inspection. Similar to the opening section of *Saeta*, the pulse is in a constant state of flux here, although the subdivision remains steady. However, a new meter and consequent time system are never truly established (the current time system stabilises in bar 123) and thus a modulation does not occur. Rather, this section contains brief interruptions to the current time system. This skewing of the time system occurs again in bars 124- 136 with the presence of a 2/3 cross-rhythm formed by the pulse (two per bar) and the written rhythm (three crotchets per bar). This cross-rhythm is unsettled by the 5/8 bar and the pulse only stabilises in bar 132, before the conclusion of the piece.

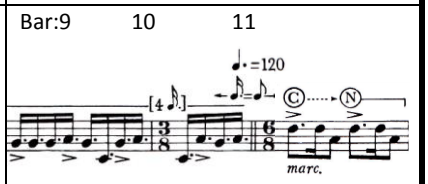
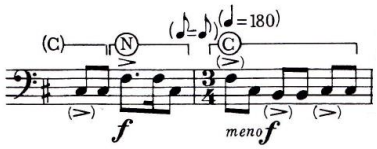
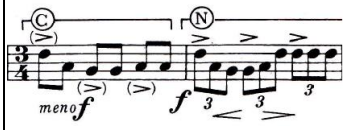
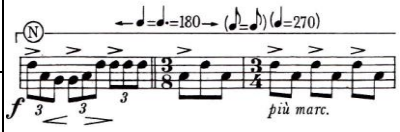
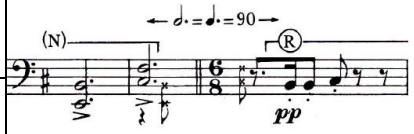
As with *Improvisation*, *Canaries* begins with a string of consecutive modulations (as seen in the table excerpt in Figure 16) in which the pulse travels through a number of tempi before arriving back at the initial tempo. Mod. 1 is prepared in a similar fashion to Mod.1 in *Improvisation* – through the use of accents in the preceding bar to de-stabalise the pulse, preparing it for the shift in the next bar. In this case, the accents occur in bar 9, creating a temporary 'pulse' on every 3rd dotted semiquaver, which will become the new pulse from bar 11. This newly established pulse only remains stable until bar 15, where it is interrupted by three 5/8 bars. This interruption pre-empts the shift in pulse tempo in Mod. 2, which occurs in bars 17 – 18. The use of opposing rhythmic groupings in the last two 5/8 bars prepares the performer for the creation of a new pulse. Mod. 2 is considered a modulation despite the fact that the time system is only established for one bar because that time system needs to have been established in order for Mod. 3 to occur.

Mod. 3 is also brief - in this modulation the pulse remains constant whilst the subdivision changes from two per pulse to three per pulse (in the form of quaver triplets). This change in subdivision sets up the 3/8 bar that begins Mod 4, in which the pulse is altered from every 3rd quaver to every 2nd quaver. The final modulation in the chain is Mod. 5.

Mod. 5 occurs in bars 24 – 25 and brings the pulse back to its original tempo. During this modulation (which is linked through a CST) the crotchet value in bar 24 becomes the quaver value in bar 25 and the pulse changes from three per bar (on every crotchet beat) to two per bar (on every dotted crotchet). The performer should carefully navigate each modulation in the chain on order to perform the following one correctly. Making use of the accents written throughout this passage may prove to be a useful tool when attempting this.

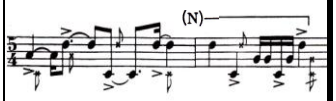
[51] Ibid.150

Figure 16. Excerpt from table of analysis of Canaries showing Mod. 1 - 5

Piece	**Canaries**							**Initial Tempo:** ♩. = 90
Mod. No.	**Method**	**Bar**	**Time Signature**	**Pulse Tempo**	**Sub. per Pulse**	**Subdivision Tempo**	**Tempo Relation**	**Musical Example**
1	CST (prepared)	9-10	9: 6/8 10:3/8	♩. = 90	4	♪. = 360	4:3	
		11	6/8	♩. = 120	3	♪=360		
2	CST (unprep.)	17	5/8	♩.=120	2 then 3	♪= 360	3:2	
		18	3/4	♩= 180	2	♪= 360		
3	CPT (unprep.)	18	3/4	♩= 180	2	♪= 360	1:1	
		19	3/4	♩= 180	3	♪3=540		
4	CST (unprep.)	20	3/8	♩.=180	3	♪= 540	4:3	
		21	3/4	♩=270	2	♪= 540		
5	CST (unprep.)	24	3/4	♩=270	1	♩=270	1:3	
		25	6/8	♩=90	3	♪=270		

Modulation 8 (which is again shown below in Figure 17) appears complicated, largely due to the difficulty in determining the subdivision present in bar 50, which forms the link in this modulation.

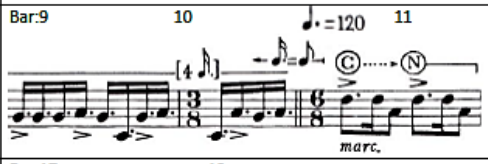
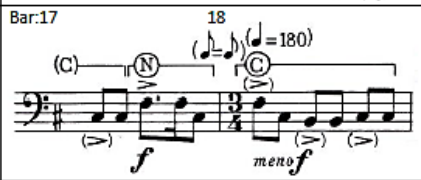
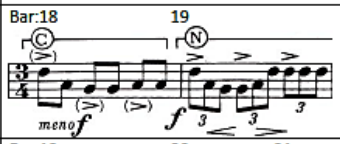
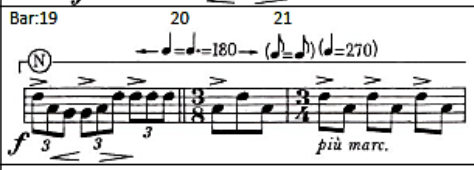
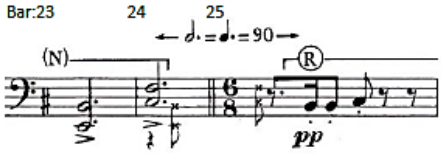
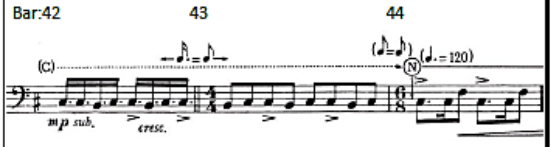
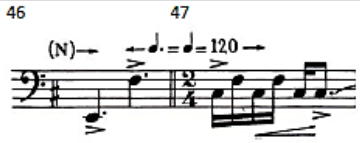
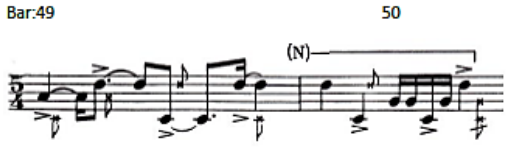
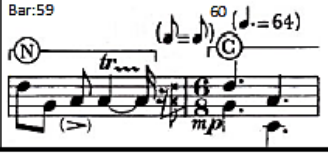
Figure 17. Excerpt from table of analysis of Canaries showing Mod. 8

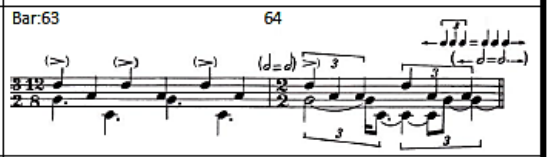
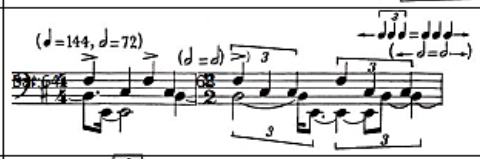
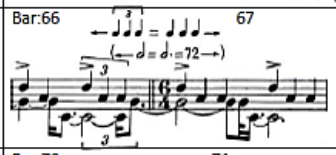
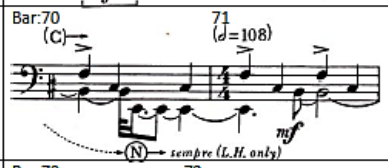
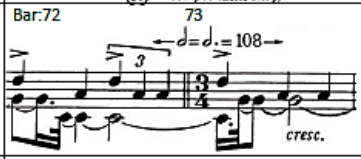
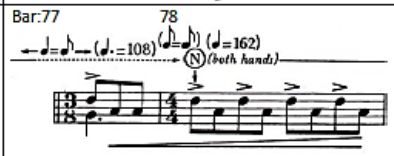
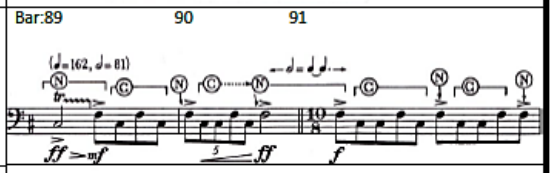
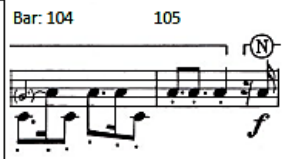
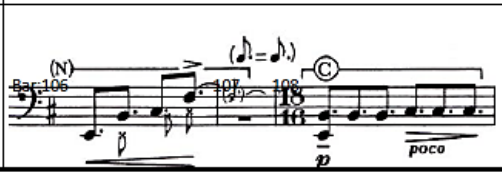
Mod. No.	Method	Bar	Time Signature	Pulse Tempo	Sub. per Pulse	Subdivision Tempo	Tempo Relation	Musical Example
8	CST (prepared)	49	5/4	♩=120	4	♪=480	4:5	Bar:49 50 
		50	4/4	♩=96	5 (implied)	♪=480		

The performer prepares the shift in pulse tempo in bar 49 by playing on every 5th semiquaver, creating the illusion that there four pulses in the bar, each subdivided into five, rather than the actual five pulses subdivided into four present. This illusion then becomes reality in bar 50, with the subdivision of five implied by the previous bar, thus keeping the subdivision tempo constant. The performer may assume however the standard subdivision of two or four per pulse applies to bar 50, making it difficult to determine the link between sections of the modulation. By examining the previous bar and becoming aware of the implied subdivision of five, the performer can accurately perform Mod. 8.

The final modulation in *Canaries*, Mod. 18, also has the potential to confuse the performer. However, creating the desired result is simply a matter of maintaining the dotted quaver subdivision through bars 106 – 108 and counting carefully in bar 107 in order to perform Mod. 8 correctly. The end result should be an alteration of pulse, shifting from every 2nd dotted semiquaver to every 3rd one.

Figure 18. Table containing the analysis of the modulations present in Canaries

Piece	Canaries							Initial Tempo: ♩ = 90
Mod. No.	Method	Bar	Time Signature	Pulse Tempo	Sub. per Pulse	Subdivision Tempo	Tempo Relation	Musical Example
1	CST (prepared)	9-10	9: 6/8 10:3/8	♩ = 90	4	♪ = 360	4:3	
		11	6/8	♩ = 120	3	♪=360		
2	CST (unprep.)	17	5/8	♩=120	2 then 3	♪= 360	3:2	
		18	3/4	♩= 180	2	♪= 360		
3	CPT (unprep.)	18	3/4	♩= 180	2	♪= 360	1:1	
		19	3/4	♩= 180	3	♪₃=540		
4	CST (unprep.)	20	3/8	♩=180	3	♪= 540	4:3	
		21	3/4	♩=270	2	♪= 540		
5	CST (unprep.)	24	3/4	♩=270	1	♩=270	1:3	
		25	6/8	♩=90	3	♪=270		
6	CST (prepared)	42-43	42: 6/8 43: 4/4	♩=90	4	♪/♪=360	4:3	
		44	6/8	♩=120	3	♪=360		
7	CPT (prepared)	46	6/8	♩=120	3	♪=360	1:1	
		47	2/4	♩=120	4	♪=480		
8	CST (prepared)	49	5/4	♩=120	4	♪=480	4:5	
		50	4/4	♩=96	5 (implied)	♪=480		
9	CST (unprep.)	59	3/4	♩=96	2	♪=192	2:3	
		60	6/8	♩=64	3	♪=192		

Mod. No.	Method	Bar	Time Signature	Pulse Tempo	Sub. per Pulse	Subdivision Tempo	Tempo Relation	Musical Example
10	CPT (prepared)	63	3/2 (ind. 12/8 or 3/2)	𝅗𝅥=48	4	𝅘𝅥𝅯=192	1:1	
		64	2/2	𝅗𝅥=48	3	𝅗𝅥.=144		
11	CST (prepared)	64	2/2	𝅗𝅥=64	3	𝅗𝅥.=144	9:8	
		65	4/4	𝅗𝅥=72	2	𝅗𝅥=144		
12	CPT (prepared)	66	4/4	𝅗𝅥=72	2	𝅗𝅥=144	1:1	
		67	6/4	𝅗𝅥=72	3	𝅗𝅥.=216		
13	CST (unprep.)	70	3/4	𝅗𝅥=72	3	𝅗𝅥=216	3:2	
		71	4/4	𝅗𝅥=108	2	𝅗𝅥=216		
14	CPT (prepared)	72	4/4	𝅗𝅥=108	2	𝅗𝅥=216	1:1	
		73	3/4	𝅗𝅥=108	3	𝅗𝅥=324		
15	CST (unprep.)	77	3/8	𝅗𝅥.=108	3	𝅘𝅥𝅮=324	3:2	
		78	4/4	𝅗𝅥=162	2	𝅘𝅥𝅮=324		
16	CST (prepared)	89	4/4	𝅗𝅥=81	4	𝅘𝅥𝅮=324	1:1	
		91	10/8	♩.♩=81	5	𝅘𝅥𝅮=405		
17	CPT (unprep.)	104	6/8	𝅗𝅥.=135	3	𝅘𝅥𝅮=405	1:1	
		105	6/8	𝅗𝅥.=135	2	𝅘𝅥𝅮=270		
18	CST (prepared)	106	6/8	𝅗𝅥.=135	2	𝅘𝅥𝅮=270	2:3	
		108	18/16	♩.𝅘𝅥𝅮=90	3	𝅘𝅥𝅮=270		

March

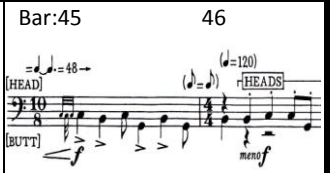
The table containing the analysis of the modulations present in *March* is shown in Figure 20.

March is the final of the five of Carter's *Eight Pieces for Four Timpani* that contains modulations. Interesting rhythmic characteristics of the work include a reoccurring 'interruption motif' and a series of modulations, which occur from bar 58 – 61.

This 'interruption' motif is first present in bar 3 and reappears in bars 14 and 74. However, its role differs in bar 14 – instead of serving as a temporary disruption of the pulse it acts as a preparation for Mod. 1, in which the doted quaver value becomes the crotchet value.

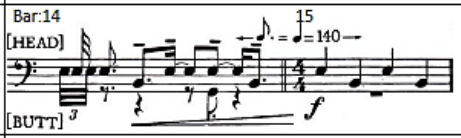
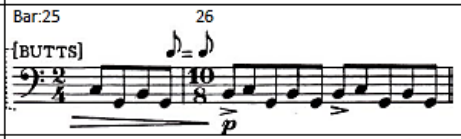
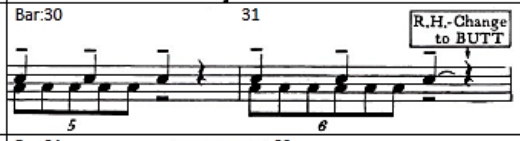
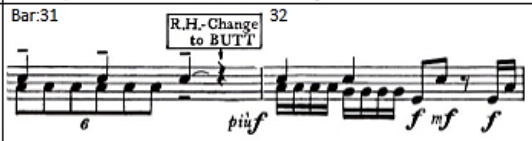
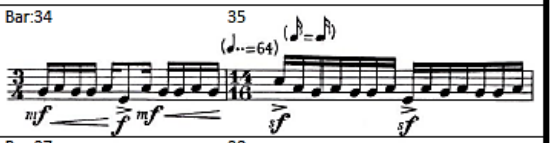
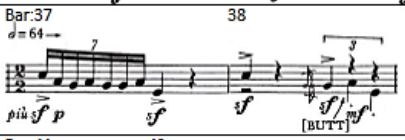
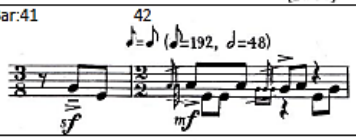
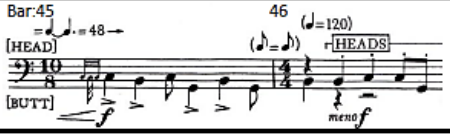
The majority of the modulations in this piece should appear logical to the performer. Mod. 8 is perhaps an exception to this statement. This modulation can be seen in the table excerpt in Figure 19 below:

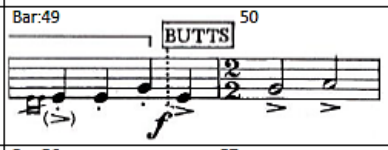
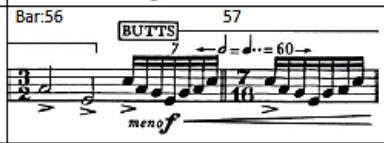
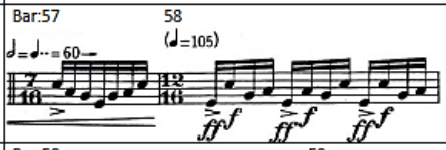
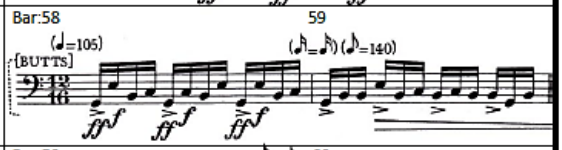
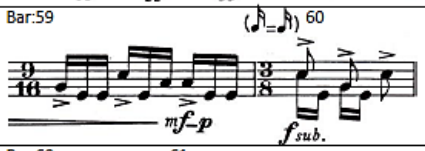
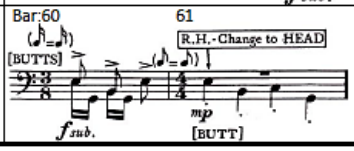
Figure 19. Excerpt from table of analysis of March showing Mod. 8

Mod. No.	Method	Bar	Time Signature	Pulse Tempo	Sub. per Pulse	Subdivision Tempo	Tempo Relation	Musical Example
8	CST (prepared)	45	10/8	♩.♩.=48	5	♪=240	5:2	
		46	4/4	♩=120	2	♪=240		

The rhythm contained in bar 45 (10/8) has the potential to prevent the performer from accurately executing the modulation. Mod. 8 is linked by a CST, a fact that is indicated by Carter. The performer should therefore subdivide the two pulses present into quavers (a total of five subdivisions per pulse) and maintain these quavers through bar 46, leading to a subdivision of two per pulse, with four pulses total in the bar. Focusing on this subdivision and not being deterred by the written rhythm will allow the performer to realise the modulation correctly.

Figure 20. Table containing the analysis of the modulations present in March

Piece	March							Initial Tempo: ♩= 105
Mod. No.	Method	Bar	Time Signature	Pulse Tempo	Sub. per Pulse	Subdivision Tempo	Tempo Relation	Musical Example
1	CST (prepared)	14	4/4	♩= 105	4	♪=420	4:3	
		15	4/4	♩= 140	3	♪3=420		
2	CST (prepared)	25	2/4	𝅗𝅥= 70	2	♪=280	4:5	
		26	10/8	𝅗𝅥.𝅗𝅥.=56	5	♪=280		
3	CPT (unprep.)	30	2/2	𝅗𝅥= 56	5	♪5=280	1:1	
		31	2/2	𝅗𝅥= 56	6	♪6=336		
4	CPT (unprep.)	31	2/2	𝅗𝅥= 56	6	♪6=336	1:1 (implied 1:2)	
		32	2/2 (implied 4/4)	𝅗𝅥= 56 (implied ♩=112)	8 (implied 4)	♪=448		
5	CST (prepared)	34	3/4	♩=112	4	♪=448	4:7	
		35	14/16	♩.=64	7	♪=448		
6	CPT (unprep.)	37	2/2	𝅗𝅥=64	7	♪=448	1:1	
		38	2/2	𝅗𝅥=64	3	♩3=192		
7	CST (unprep.)	41	3/8	♩=64	3	♪=192	3:4	
		42	2/2	𝅗𝅥=48	4	♪=192		
8	CST (prepared)	45	10/8	𝅗𝅥.𝅗𝅥.=48	5	♪=240	5:2	
		46	4/4	♩=120	2	♪=240		

Mod. No.	Method	Bar	Time Signature	Pulse Tempo	Sub. per Pulse	Subdivision Tempo	Tempo Relation	Musical Example
9	CST (unprep.)	49	4/4	♩=120	2	♪=240	1:2	
		50	2/2	𝅗𝅥=60	4	♪=240		
10	CPT (prepared) (from b. 51)	56	3/2	𝅗𝅥=60	2	♩=120	1:1	
		57	7/16	♩.=60	7	𝅘𝅥𝅯=420		
11	CST (unprep.)	57	7/16	𝅗𝅥=60	7	𝅘𝅥𝅯=420	7:4	
		58	12/16	♩=105	4	𝅘𝅥𝅯=420		
12	CST (prepared)	58	12/16	♩=105	4	𝅘𝅥𝅯=420	4:3	
		59	12/16	♪.=140	3	𝅘𝅥𝅯=420		
13	CST (prepared)	59	9/16	♪.=140	3	𝅘𝅥𝅯=420	3:2	
		60	3/8	♪=210	2	𝅘𝅥𝅯=420		
14	CST (unprep.)	60	3/8	♪=210	3	𝅘𝅥𝅯=420	1:2	
		61	4/4	♩=105	4	𝅘𝅥𝅯=420		

Chapter 4

An Analysis of Recordings of *Improvisation*

This chapter contains analysis of three recordings in total - those of professional percussionists/ timpanists - Sylvio Gualda (1939 – present, Algeria), Daniel Druckman (USA) and Florent Jodelet (1962 – present, France). These recordings have been analysed in order to support the argument that performing the *Eight Pieces for Four Timpani* accurately is difficult and that creating click tracks is therefore a worthwhile task, as they can be used to assist in increasing the rhythmic accuracy of a performance. Each recording has been carefully selected based on a few important criteria. Firstly, each recording is from a different point in time, thus allowing the evolution of *Improvisation* (in terms of approach, interpretation and performance) to become apparent. Gualda's performance is from 1978 and is one of the first recordings of any of the *Eight Pieces for Four Timpani*, Druckman's recording was made in 2006 and Jodelet's is the most current, being recorded in 2013. Secondly, these recording were selected because they were performed by well-known and reputable artists. Sylvio Gualda is a percussion soloist and has been extremely active in developing the solo percussion genre, working with Iannis Xenakis (1922 – 2001, Romania) to develop works such as *Rebonds*. "Percussionist Daniel Druckman is active as a soloist, chamber and orchestral musician, and recording artist, concertizing throughout the United States, Europe, and Japan."[52] He is also currently the Associate Principal Percussionist of the New York Philharmonic. Florent Jodelet is a soloist with the Orchestre National de France and assistant professor at the Conservatoire National Superieur de Musique de Paris.

The analysis of each recording has been presented in three different formats. The first is a table, similar to those used in Chapter 3. Within each table, correct modulations according to the predicted tempo are highlighted in purple and modulations which do not adhere to the predicted tempo but are contextually correct given the tempo set in the previous section are highlighted in brown. The second form of analysis is a spectrogram and the third is an image of each recording's soundwaves, generated through the editing program, 'Audacity'.

The spectrograms in this dissertation have been produced using Chris Cannam's 'Sonic Visualiser' software distributed by Queen Mary, University of London. They are a visual representation of the recording concerned, presenting the melodic and rhythmic aspects of a performance from a different angle. The following parameters were observed when creating each spectrogram: Maximum Window Size of 16384, Window Overlap of 93.75%, and the Normalize Visible Area function on (allotting the loudest sounds present in the recording the brightest colour). These parameters have been selected in order to make the rhythmic aspects present in the image as clear and obvious as possible, allowing for more in-depth comparisons between spectrograms to be made. Each image was exported as a .png file using the default colour settings, where green represents frequencies of low energy and red represents frequencies of high energy. This paper contains a sample of these spectrograms, with the full image and analysis on the CD provided.

The other images presented in this chapter were produced by the free multi-track editing program, 'Audacity'. These images comprise of two tracks; the first/ top track in each image is the audio of the recording concerned and the second/bottom track is the click track audio. Each recording has a separate click track, created based on the pulse tempo present in the first two bars of the piece which, in this case, is also usually the average performance tempo of section A. This is due to the fact that whilst the performer may come in and out of 'time' throughout their performance, it is assumed that they begin 'in time' ('time' as an entity is created and set by the performer). The purpose of these

[52] Alan Gilbert, "Daniel Druckman," http://nyphil.org/about-us/ArtistDetail?artistname=daniel-druckman.

images is to provide visual evidence of whether or not the performer realizes the rhythms and modulations correctly throughout the performance by aligning their recording with the click track.

Each 'Audacity' image in this dissertation is anaylsed using various colours, each representing a different rhythmic component within the recording. The red lines represent the pulse present in the click track, the black lines represent the bars as per the recording (the thinner black lines occur when the bar line close to the pulse and the thicker black lines occur when the bar line is not close to the pulse) and the other colours represent the various functions/ states of the pulse itself. The yellow lines shows the impending pulse before Mod. 1 occurs, with the green line showing the same pulse as is occurs in the performance (these lines should theoretically line up if the performer has kept perfect time). The white line represents the transformation the pulse has undergone post – Mod.1 and the pink line shows its next manipulation, which occurs in Mod. 2.

Each image only contains the first two modulations in each recording (approx. 35 – 40 seconds of music). This is due to the fact that these images are intended to serve as an example of the necessity for the click tracks, the function of the tracks and the possible rhythmic/ timing trends present throughout each performance. In this paper, a sample of each image is presented, with the full image available on the CD provided.

Sylvio Gualda Recording

The table, spectrogram (sample) and 'Audacity' analysis (sample) for Sylvio Gualda's recording of *Improvisation* are shown in Figure 22, Figure 23 and Figure 24 respectively.

Gualda's performance of *Improvisation* provides strong evidence to support the argument that click tracks are a worthwhile creation for the *Eight Pieces for Four Timpani*. Throughout his performance, Gualda drops and adds beats, plays rhythms incorrectly and, most importantly, rarely performs a modulation correctly, even within the context of the average performance tempo he sets in the preceding section. Furthermore, there are sections in Gualda's performance in which an average performance tempo is unable to be determined. This is due to the fact that he does not maintain a constant pulse, sometimes even between successive beats.

Gualda starts his performance quite close to the written tempo. However, within section A he begins to deviate from the music and as a consequence does not set up a stable pulse tempo within which to perform Mod. 1. The link between sections of the modulation is not maintained; it sounds as if Gualda has skewed the rhythm in the bars concerned, turning the rhythm in the ¾ bar into crotchets in the previous tempo then performing a quaver-like rhythm in b.16. Gualda stabalises the pulse in Mod. 2, allowing for an accurate realisation. Mod. 3 follows suit, also accurate. (The only other modulation that is contextually accurate throughout the recording is Mod. 7). This information can be seen in Figure 21 below:

Figure 21. Excerpt from table of analysis of Sylvio Gualda's recording of Improvisation

Section/ Modulation	Bar	Time (as per click track)	Time (recording)	Written Tempo	No. of Beats Written	No. of Beats Performed (approx.)	Average Performance Tempo	No. of Beats Contained (at written tempo)	Other Issues/ Comments	Next Mod. Given Inaccuracy
A	1 - 14	0.04 –0.30	0.02 –0.28	♩= 126	57	55	Range: ♩= 114 – 146 ♩= 124	47	b. 4, 11, 13 – missing 1 beat b. 7 – added 1 beat b. 5 – incorrect rhythm in beat 3 Pulse is rarely kept stable throughout	♩= 165.3
Mod. 1	15	0.31 –0.32	0.29 –0.30	♩= 126	3	3	R: ♩= 121 – 123 ♩= 123	4	b. 15 is rhythmically inaccurate (played as 4/4 with notes on beat 1) Mod. 1 is incorrect – link is not maintained	♩= 164
	16	0.32 –0.33	0.31 –0.32	♩= 168	4	4	R: ♩= 200-209 ♩= 204	3		
Mod 2.	16	0.32 –0.33	0.31 –0.32	♩= 168	4	4	R: ♩= 200-209 ♩= 204	3	Pulse more stable throughout b. 16 - 17	♩= 204
	17	0.34 –0.35	0.32 –0.33	♩= 168	4	4	R: ♩= 202-211 ♩= 205	3		

.

One of the more inaccurate sections in Gualda's performance is section C (b. 26 – 39). In addition to a number of rhythmic errors, the pulse tempo is noticeably unstable throughout. In b. 31 the pulse tempo increases suddenly, before decreasing just as abruptly in b. 36. Another noticeably incorrect section in the performance is Mod. 8. Gualda fails to observe bar 99 (a bar of rests), causing this modulation to not occur at all.

Both the spectrogram and the 'Audacity' image offer a valuable insight into the rhythmic qualities of Gualda's performance. The spectrogram provides visual evidence of the irregularity of the pulse within each modulation (of particular clarity is Mod. 1, in which the pulse can be seen in red). The 'Audacity' image also presents this information, as well as making clear the bars in which beats are dropped and added (such as in b. 4 and 11, both of which are missing one beat).

There may be an explanation for Gualda's rhythmically malleable interpretation of *Improvisation*. Firstly, Gualda's career began in 1968, during a period when percussion as a genre was evolving and being reinvented, changing its role in the music community from a relatively unknown genre to one of much popularity. 'Solo' percussion appeared in compositions as early as the 18th century, such as in Johann Carl Fischer's *Concerto for Eight Timpani and Orchestra*, which was written in 1785. However, "for many years after, the timpanists' and percussionists' moments of glory were very few and far between"[53]. Furthermore, when percussionists were gifted with a solo, it was in the context of a larger work, rather than being a piece *for* the solo percussionist.

The genre continued to develop, with composers such as Xenakis contributing the collection of repertoire with innovative new works. Starting in the 1930's and peaking throughout the 1960's and 1970's, composers and performers continued to explore solo percussion as a genre in much more depth, experimenting with extended techniques and new instruments and the rate of composition of solo and ensemble works for percussion greatly increased. Carter's *Eight Pieces for Four Timpani* are an example of this experimentation and discovery. As a consequence of these changing views towards percussion, many performers (including Gualda) may not have considered Carter's timpani works to be "a study in tempo modulation"[54] as we do today and as such, may have considered musicality and exploration into the timbral manipulation contained in the works to be of greater importance than rhythmic accuracy.

Another possible explanation for Gualda's performance of *Improvisation* is simply that this type of interpretation may be part of his musical identity. Gualda's performances are typically characterised as having flare and a great deal of musicality – he is known for his charisma and ability to 'perform'. Part of this 'performance' quality may include the manipulation of time on a frequent basis. However, upon examination of the more recent recordings to be discussed in this dissertation the importance of click tracks is still evident.

[53] James Holland, *Practical Percussion: A Guide to the Instruments and Their Sources* (USA: Scarecrow Press, 2005).67
[54] Schiff, *The Music of Elliott Carter*.

Figure 22. Table containing the analysis of the modulations present in Sylvio Gualda's performance of Improvisation

Section/ Modulation	Bar	Time (as per click track)	Time (recording)	Written Tempo	No. of Beats Written	No. of Beats Performed (approx.)	Average Performance Tempo	No. of Beats Contained (at written tempo)	Other Issues/ Comments	Next Mod. Tempo Given Perf. Tempo
A	1 - 14	0.04 – 0.30	0.02 – 0.28	♩= 126	57	55	Range: ♩= 114 – 146 ♩= 124	47	b. 4, 11, 13 – missing 1 beat b. 7 – added 1 beat b. 5 –incorrect rhythm in beat 3 Pulse is rarely kept stable throughout	♩= 165.3
Mod. 1	15	0.31 – 0. 32	0.29 – 0.30	♩= 126	3	3	R: ♩= 121 – 123 ♩= 123	4	b. 15 is rhythmically inaccurate (played as 4/4 with notes on beat 1) Mod. 1 is incorrect – link is not maintained	♩= 204
	16	0.32 – 0.33	0.31 – 0.32	♩= 168	4	4	R: ♩= 200-209 ♩= 204	3		
Mod 2.	16	0.32 – 0.33	0.31 – 0.32	♩= 168	4	4	R: ♩= 200-209 ♩= 204	3	Pulse more stable throughout b. 16 - 17	𝅗𝅥= 102.5
	17	0.34 – 0.35	0.32 – 0.33	♩= 168	4	4	R: ♩= 202-211 ♩= 205	3		
Mod. 3	17	0.34 – 0.35	0.32 – 0.33	♩= 168	4	4	R: ♩= 202-211 ♩= 205	3	Pulse remains stable b 18 beat 2 is inaccurate – played ♪6 instead of written ♪5	𝅗𝅥.𝅗𝅥=72.8
	18	0.35 - 0.36	0.34 – 0.34 (> 1 second)	♩=168 (𝅗𝅥=84)	2	2	R: ♩= 101-103 𝅗𝅥= 102	2		
B	19 - 23	0.37 – 0.43	0.35 – 0.41	𝅗𝅥=84	10	9	R: 𝅗𝅥=79 – 86 ♩=85	9	b.23 – missing 1 beat Pulse decreases in tempo slightly in this section and is unsteady. Settles at point of Mod. 4	N/A
Mod. 4	24	0.44 – 0.45	0.41 – 0.42	𝅗𝅥.𝅗𝅥=84	2	2	𝅗𝅥.𝅗𝅥=79 – 84 𝅗𝅥.𝅗𝅥=83	>2	Pulse accelerates slightly here, leading to an inaccurate performance of this modulation	𝅗𝅥.𝅗𝅥=52
	25	0.45 – 0.46	0.42 – 0.43	𝅗𝅥.𝅗𝅥=60	1	1	R=𝅗𝅥.𝅗𝅥=60 – 66 𝅗𝅥.𝅗𝅥=65	>1		

Section/ Modulation	Bar	Time (as per click track)	Time (recording)	Written Tempo	No. of Beats Written	No. of Beats Performed (approx.)	Average Performance Tempo	No. of Beats Contained (at written tempo)	Other Issues/ Comments	Next Mod. Tempo Given Perf. Tempo
C	26 - 39	0.47 – 1.13	0.44 – 1.03	𝅗𝅥=60	28	28	R:𝅗𝅥=48 – 100 𝅗𝅥=indeterminable	20	b.28 beat 2 is inaccurate – played a 𝅘𝅥𝅯8 instead of the written 𝅘𝅥𝅰 7. b.29 beat 1 is inaccurate – played a 𝅘𝅥𝅯6 instead of the written 𝅘𝅥𝅰 7 b.31 – 35 jump up in tempo. b. 36 – 37 are noticeably slower in tempo	N/A
Mod. 5	40	1.14 – 1.16	1.03 – 1.05	𝅗𝅥=120	5	5	R:𝅗𝅥=149 – 156 𝅗𝅥=152	4	Pulse tempo is unstable in previous bars, contributing to a faster pulse tempo in b. 40	𝅗𝅥=98
	41	1.16 – 1.17	1.05 – 1.07	𝅗𝅥.𝅘𝅥𝅯=48	2	2	R:𝅗𝅥.𝅘𝅥𝅯=54 – 56 𝅗𝅥.𝅘𝅥𝅯=56	<2		
D	42- 45	1.18 – 1.28	1.07 – 1.17	𝅗𝅥=48	8	8	R:𝅗𝅥=45 – 53 𝅗𝅥=indeterminable	9	Section is inaccurate due to lack of effective subdivision– does not rhythmically accelerate as a consequence. Pulse tempo gradually decreases	N/A
Mod. 6	46	1.29 – 1.30	1.17 – 1.18	𝅗𝅥=48	1	1	R:𝅗𝅥=43 – 45 𝅗𝅥=43	>2	Pulse is hard to determine here but in b. 47 the pulse is stable	𝅗𝅥=92
	47	1.31 – 1.32	1.18 – 1.19	𝅗𝅥=84	2	2	R:𝅗𝅥=78 – 84 𝅗𝅥=80	<2 (almost 3)		
E	48-70	1.33 – 1.59	1.20 – 1.47	𝅗𝅥=84	47	47	R:𝅗𝅥=90 – 117 𝅗𝅥=92	39	Pulse accelerates in b. 49 but then stays constant until b.59, where it is slower. At b. 61 – 64, pulse is faster, but settles at the original tempo from b.65 onwards. Rest in b. 68 is short	N/A

Section/ Modulation	Bar	Time (as per click track)	Time (recording)	Written Tempo	No. of Beats Written	No. of Beats Performed (approx.)	Average Performance Tempo	No. of Beats Contained (at written tempo)	Other Issues/ Comments	Next Mod. Tempo Given Perf. Tempo
Mod. 7	71	2.00 – 2.01	1.48 – 1.49	𝅗𝅥=84	2	2	R:𝅗𝅥=106 - 110 𝅗𝅥=109	>2	Pulse is stable throughout this section	𝅗𝅥=244.5
	72	2.01 – 2.02	1.49 – 1.50	♩=126	3	3	R:𝅗𝅥=158 – 166 𝅗𝅥=163	<2		
F	73-97	2.02 – 2.37	1.51 – 2.18	♩=126	72	71	R:♩=124 - 150 ♩=undetermin-able	58	Pulse is slightly unstable. b. 80 is missing <1 beat. Rhythm in b. 83 is clipped. Other rhythmic variants are also present but more subtle. Pulse is hard to determine due to this but settles in b. 95	N/A
Mod. 8	98	2.37 – 2.38	2.18 – 2.20	♩=126	2	2	R:♩=106 -110 ♩=107	>5	Pulse is slow but stable in this bar but is drastically altered post-modulation	N/A due to missing bar (99)
	99	2.38 – 2.39	N/A	♩=126	2	N/A	N/A	N/A	b. 99 is not observed at all in the performance	
Mod. 9	100	2.39 – 2.40	2.21 – 2.22	♩=126	2	2	R:♩=68 - 73 ♩=72	>5	Pulse in b. 100 is drastically slower, followed by a sudden increase in pulse tempo in b. 101	N/A
	101	2.40 – 2.41	2.22 – 2.23	♩=189	4	4	R:♩=197 - 209 ♩=206	3		
G	102 - 120	2.42 – 3.05	2.24 – 2.52	♩=189	76	73	R:♩=193 – 204 ♩=193	92	b. 102 is missing 1 beat. In b. 103 ♩ are on b. 1 and 2, followed by the roll on 3, which then lasts the appropriate duration to set pulse in b.106. Pulse then stays fairly constant until the end of the piece, only fluctuating slightly in places	N/A

Figure 23. Sample of the spectrogram of Sylvio Gualda's recording of Improvisation

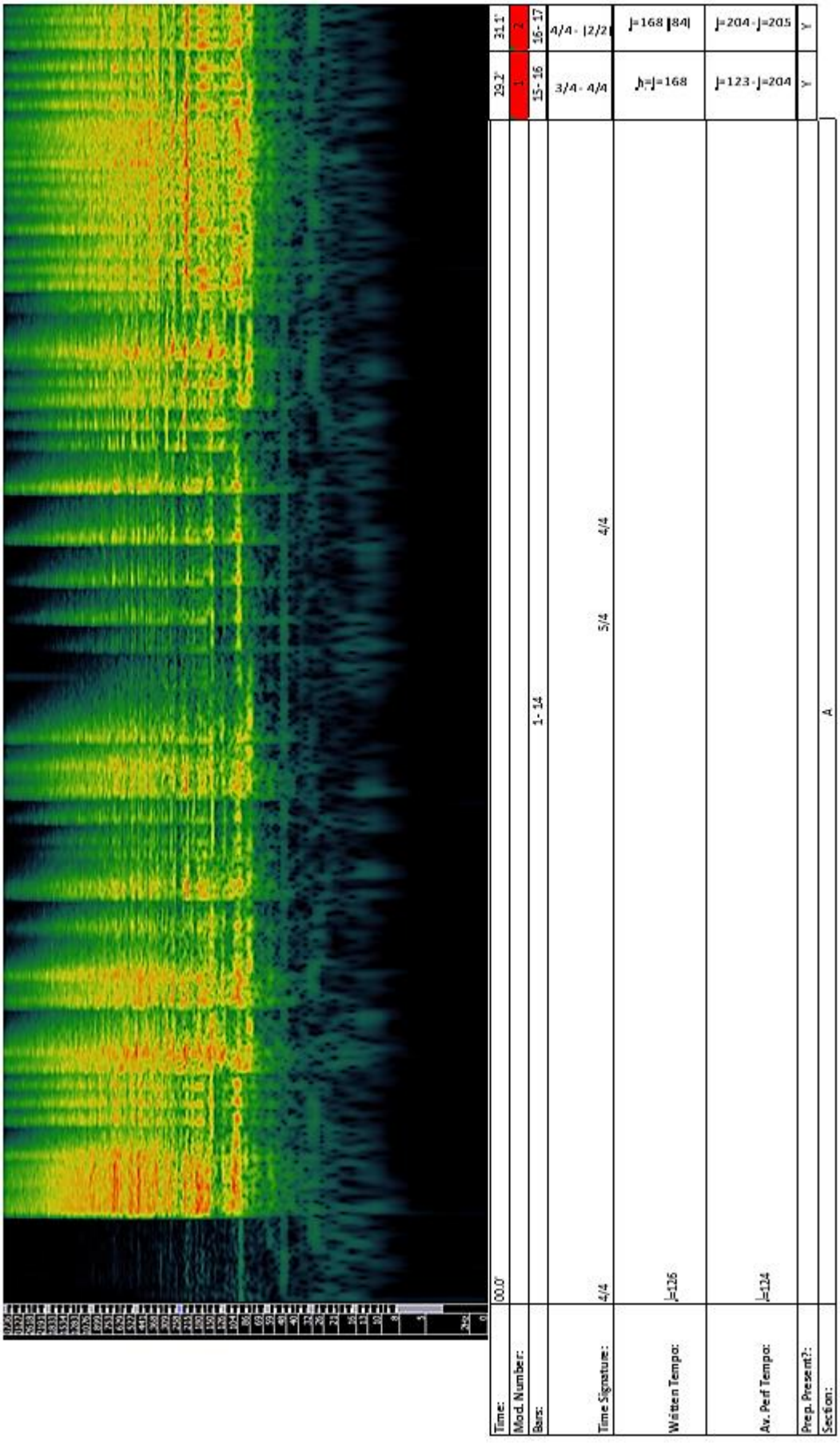
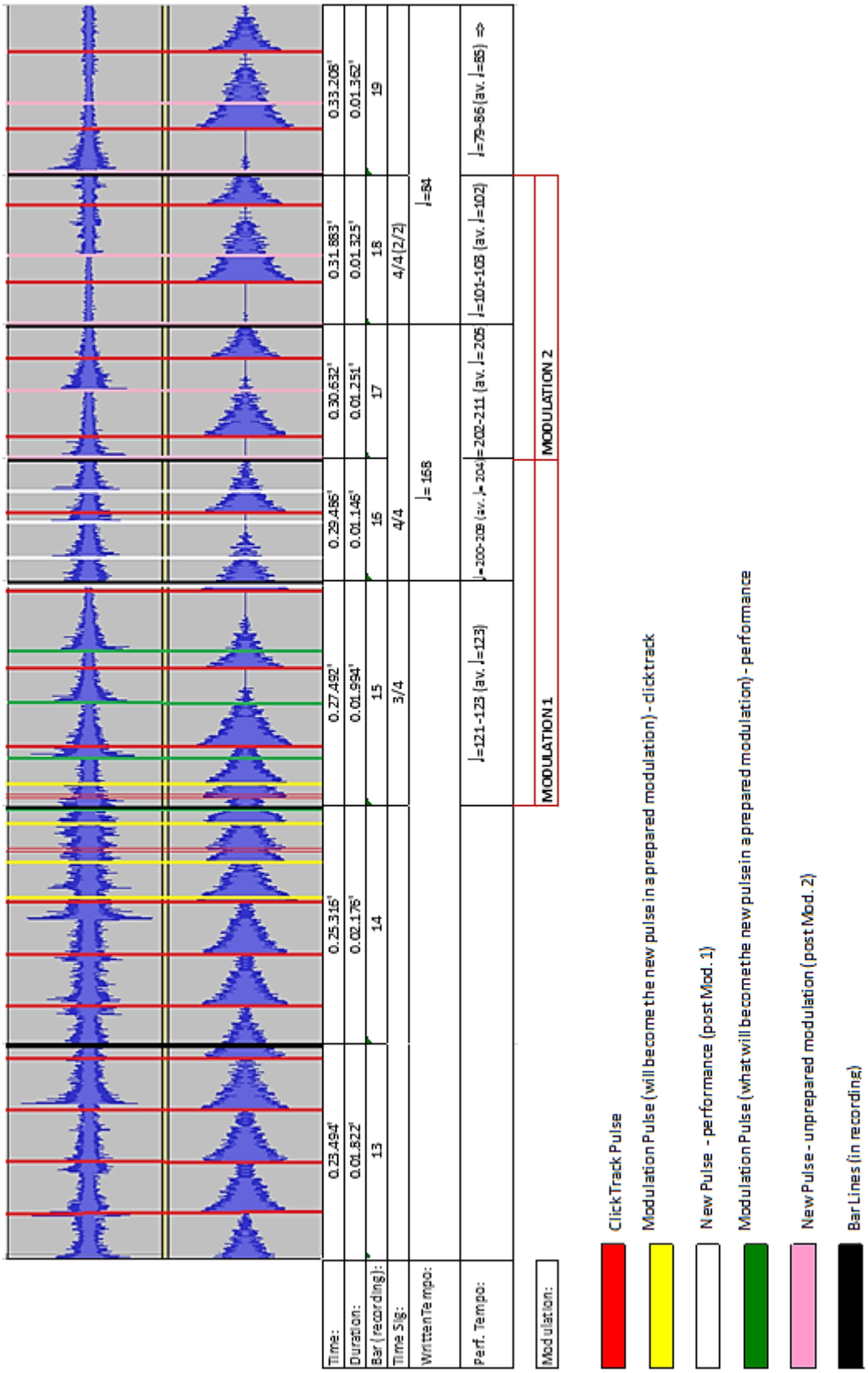


Figure 24.Sample of the 'Audacity' image analysis of Sylvio Gualda's recording of Improvisation



Daniel Druckman Recording

Figure 26, Figure 27 and Figure 28 present the analysis for Daniel Druckman's performance of *Improvisation*.

Throughout his performance of *Improvisation*, Druckman pays strict attention to the modulations and rhythmic elements contained, endeavouring to perform them cleanly and with precision. For the most part he is successful, especially in the beginning sections of the piece. However, he does wander from his set pulse tempo at various points throughout his performance, something that may be improved through the use of a click track. As such, Druckman's performance still contributes positively to the argument supporting the use of click tracks – it demonstrates that even the most rhythmically proficient performer can still improve their rhythmic accuracy and ability to correctly perform the modulations contained in Carter's *Eight Pieces for Four Timpani*.

Druckman begins his performance, like Gualda, very close to the written tempo. However, unlike Gualda, he maintains a steady pulse tempo and is able to perform all rhythms contained correctly. As a consequence of his ability to do this, Mod. 1 and Mod.2 are both very accurate. The first signs of Druckman wavering in terms of pulse tempo occur in Mod. 3. Although the modulation is still fairly accurate (it is only performed three metric beats faster than it should have been), the slight increase in pulse tempo is carried into the next sections of the piece, effecting the remaining music.

Throughout section B Druckman rushes through the quaver quintuplets, further increasing the pulse tempo. This increase continues through Mod. 4 which, despite taking this new tempo into account, is still performed too fast (and is therefore 'contextually incorrect'.) Druckman does regain a stronger sense of pulse in section C, in which the pulse tempo settles and becomes stable by b. 31. This can be seen in table in Figure 25.

Due to this stabilization of the pulse, Mod. 5 and Mod. 6 are able to be performed contextually correct. However, Druckman again accelerates through section E and therefore Mod. 7 is not performed at the predicted tempo. However, the relationship within the modulation (between b. 71 and b.72) is correct. The pulse deviates again in the bars prior to Mod. 8, leading it to be inaccurate but is maintained and correctly manipulated throughout Mod. 9, allowing the last modulation of the piece to be precisely executed.

By studying the 'Audacity' image of Druckman's recording it becomes clear which bars are elongated and which are truncated throughout the performance, thus demonstrating where he gains and loses time and perhaps even in which beat this occurs. Furthermore, the image demonstrates that, whilst Druckman is ultimately 'out of time' in relation to the click track, Mod. 1 and Mod. 2 are executed accurately (as can be seen by the even spacing between the lines that represent the pulse in each modulation).

The spectrogram also provides some interesting insight into Druckman's performance. Of particular interest is the section between Mod. 3 and Mod. 6, in which the increase in pulse tempo is evident, as it the stabilisation of the pulse just prior to Mod. 5 and throughout Mod. 6. The preparation before Mod.9 is also visible and appears evenly spaced, providing evidence for how Mod.9 is performed and why it is done so accurately.

Figure 25. Excerpt from the table of analysis of Daniel Druckman's recording of Improvisation showing section B - C

Section/ Modulation	Bar	Time (as per click track)	Time (recording)	Written Tempo	No. of Beats Written	No. of Beats Performed (approx.)	Average Performance Tempo	No. of Beats Contained (at written tempo)	Other Issues/ Comments	Next Mod. Given Inaccuracy
B	19 - 23	0.37 – 0.43	0.34 – 0.40	𝅗𝅥=84	10	10	R: 𝅗𝅥=81 – 91 𝅗𝅥=88	9	The 𝅘𝅥𝅯 5s are rushed slightly in this section, leading to an increase in pulse tempo.	N/A
Mod. 4	24	0.44 – 0.45	0.40 – 0.41	♩.♩=84	2	2	♩.♩=89 - 94 ♩.♩=90	<2	This slightly faster pulse tempo is maintained here but the modulation is still performed slightly faster than intended	♩.𝅘𝅥𝅯=54.4
	25	0.45 – 0.46	0.41 – 0.42	♩.♩=60	1	1	R=♩.♩= 65 - 73 ♩.♩=68	<2		
C	26 - 39	0.47 – 1.13	0.43 – 1.07	𝅗𝅥=60	28	28	R:𝅗𝅥=63 - 75 𝅗𝅥=64	24	Pulse tempo increases slightly in b. 27 – 30 but settles in b. 31 and remains stable throughout the rest of this section	N/A

Druckman's recording may also demonstrate a shift in approach to Carter's *Eight Pieces for Four Timpani*. This recording was made in 2006, almost 20 years after Gualda's recording was made. In the span of two decades, 'percussion' as a musical identity had become much more defined – it had acquired its own set of musical parameters, sound profiles and influential works and composers. As such, works such as Carter's *Eight Pieces for Four Timpani* (which had now been part of the repertoire for many years) had been performed and recorded by many musicians, thus establishing a tradition associated with them. Percussionists began to experiment less and less with Carter's timpani pieces as Gualda and his colleagues had done and instead focused more on their rhythmic profiles, having realised that metric and temporal modulation were an integral part of the works.

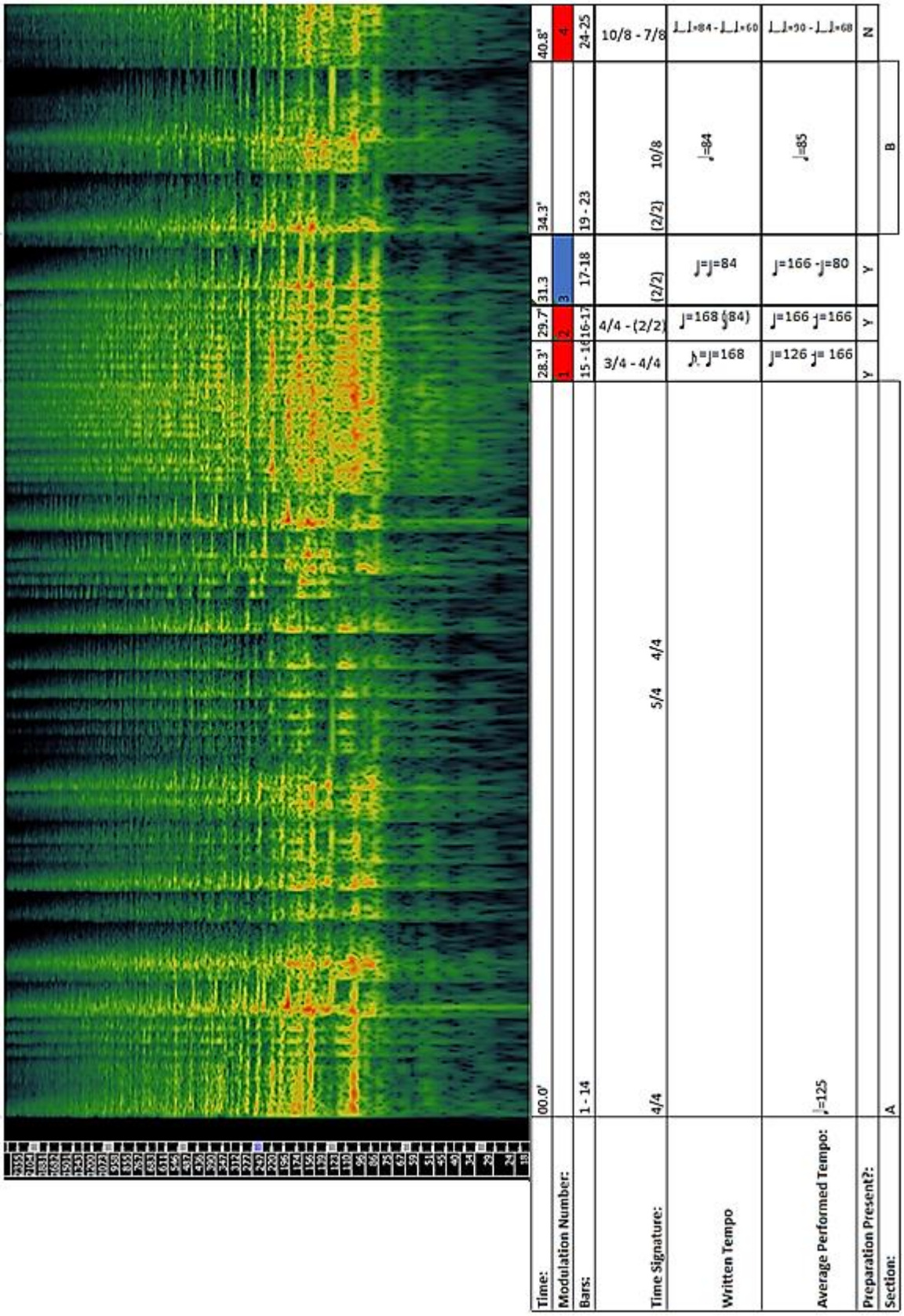
Whilst this analysis brings to light the stark contrast between Gualda's performance and Druckman's in terms of rhythmic accuracy, it also draws parallels between the two performances, most importantly that both contain some degree of rhythmic inaccuracy and could therefore benefit from the application of a click track.

Figure 26. Table containing the analysis of the modulations present in Daniel Druckman's performance of Improvisation

Section/ Modulation	Bar	Time (as per click track)	Time (recording)	Written Tempo	No. of Beats Written	No. of Beats Performed (approx.)	Average Performance Tempo	No. of Beats Contained (at written tempo)	Other Issues/ Comments	Next Mod. Tempo given Perf. Tempo
A	1 - 14	0.04 – 0.30	0.00 – 0.27	♩= 126	57	57	Range: ♩= 116 – 136 ♩= 125	59	Pulse is initially unsteady and slows slightly in b. 8 – 10 but is otherwise stable	♩= 166.6
Mod. 1	15	0.31 – 0. 32	0.27 – 0.29	♩= 126	3	3	R: ♩= 124 – 129 ♩= 126	3	Pulse is very steady here. Mod. 1 is performed accurately	♩= 166
	16	0.32 – 0.33	0.29 – 0.30	♩= 168	4	4	R: ♩= 163 - 169 ♩= 166	<4		
Mod 2.	16	0.32 – 0.33	0.29 – 0.30	♩= 168	4	4	R: ♩= 163 - 169 ♩= 166	<4	Pulse tempo remains constant, allowing for an accurate performance of Mod. 2	𝅗𝅥= 83
	17	0.34 – 0.35	0.30 – 0.31	♩= 168	4	4	R: ♩= 165- 168 ♩= 166	<4		
Mod. 3	17	0.34 – 0.35	0.30 – 0.31	♩= 168	4	4	R: ♩= 165- 168 ♩= 166	<4	Pulse slows slightly during this modulation but feels 'settled' rather than slower. The Mod. is still quite accurate	𝅗𝅥.𝅗𝅥= 57.1
	18	0.35 - 0.36	0.32 – 0.33	♩=168 (𝅗𝅥=84)	2	2	R: 𝅗𝅥= 79 - 81 𝅗𝅥= 80	<2		
B	19 - 23	0.37 – 0.43	0.34 – 0.40	𝅗𝅥=84	10	10	R: 𝅗𝅥=81 – 91 𝅗𝅥=88	9	The ♪ 5s are rushed slightly in this section, leading to an increase in pulse tempo.	N/A
Mod. 4	24	0.44 – 0.45	0.40 – 0.41	𝅗𝅥.𝅗𝅥=84	2	2	𝅗𝅥.𝅗𝅥=89 - 94 𝅗𝅥.𝅗𝅥=90	<2	This slightly faster pulse tempo is maintained here but the modulation is still performed slightly faster than intended	𝅗𝅥.♪=54.4
	25	0.45 – 0.46	0.41 – 0.42	𝅗𝅥.𝅗𝅥=60	1	1	R=𝅗𝅥.𝅗𝅥= 65 - 73 𝅗𝅥.𝅗𝅥=68	<2		
C	26 - 39	0.47 – 1.13	0.43 – 1.07	𝅗𝅥=60	28	28	R:𝅗𝅥=63 - 75 𝅗𝅥=64	24	Pulse tempo increases slightly in b. 27 – 30 but settles in b. 31 and remains stable throughout the rest of this section	N/A

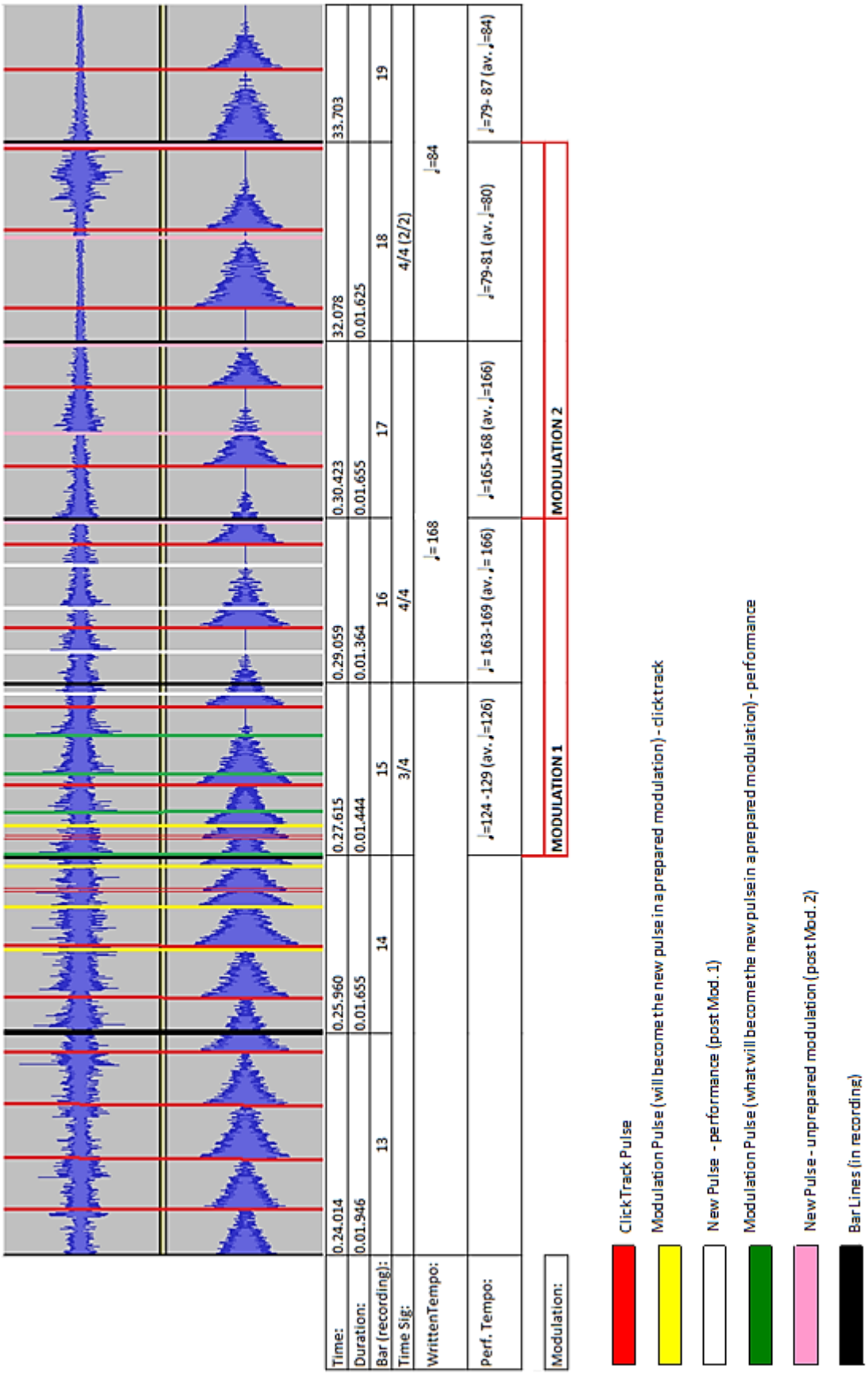
Section/ Modulation	Bar	Time (as per click track)	Time (recording)	Written Tempo	No. of Beats Written	No. of Beats Performed (approx.)	Average Performance Tempo	No. of Beats Contained (at written tempo)	Other Issues/ Comments	Next Mod. Tempo given Perf. Tempo
Mod. 5	40	1.14 – 1.16	1.07 – 1.09	♩=120	5	5	R:♩= 123 - 127 ♩=125	<5	Pulse remains quite constant throughout this modulation, which is also accurate	♩=87.5
	41	1.16 – 1.17	1.09 – 1.11	𝅗𝅥.𝅘𝅥𝅮=48	2	2	R:𝅗𝅥.𝅘𝅥𝅮=50 - 53 𝅗𝅥.𝅘𝅥𝅮=50	2		
D	42- 45	1.18 – 1.28	1.12 – 1.21	𝅗𝅥=48	8	8	R:𝅗𝅥=51 - 55 𝅗𝅥=53	>8	Pulse is increased slightly here due to the rhythmic acceleration	N/A
Mod. 6	46	1.29 – 1.30	1.21 – 1.22	♩=48	1	1	R:♩=46 - 50 ♩=48	2	Pulse tempo settles again here, back to the original written tempo. Mod. 6 is performed accurately	♩=127.5
	47	1.31 – 1.32	1.22 – 1.23	♩=84	2	2	R:♩=84 - 88 ♩=85	2		
E	48-70	1.33 – 1.59	1.23 – 1.53	♩=84	47	47	R:♩=83 - 96 ♩=89	43	Pulse tempo increases from b. 60 due to shortened rolls and slightly rushed 𝅘𝅥𝅯s leading into Mod. 7	N/A
Mod. 7	71	2.00 – 2.01	1.53 – 1.54	♩=84	2	2	R:♩=94 - 100 ♩=95	>2	Pulse is increased again here but remains steady throughout the bars in which Mod. 7 occurs	♩=143
	72	2.01 – 2.02	1.54 – 1.55	♩=126	3	3	R:♩=142 - 145 ♩=143	<2		
F	73-97	2.02 – 2.37	1.56 – 2.27	♩=126	72	73	R:♩=127 - 166 ♩= 135	66	Pulse tempo decreases here during some dotted rhythms and rest sections, before a sudden increase in b. 95-97. b. 76 is almost 1 beat longer than written	N/A
Mod. 8	98	2.37 – 2.38	2.27 – 2.28	♩=126	2	2	R:♩=152 - 163 ♩=156	<1	The sudden pulse tempo increase that occurred in b. 95 – 97 is maintained throughout this modulation, making it contextually correct	♩=232.5
	99	2.38 – 2.39	2.28 – 2.29	♩=126	2	2	R:♩=152 - 160 ♩=156	<1		
Mod. 9	100	2.39 – 2.40	2.29 – 2.30	♩=126	2	2	R:♩152 - 157 ♩=155	<1	Pulse is maintained here, allowing for a correct realisation	N/A
	101	2.40 – 2.41	2.30 – 2.31	♩=189	4	4	R:♩ = 225 - 233 ♩=230	<3		
G	102 - 120	2.42 – 3.05	2.32 – 2.56	♩=189	76	76	R:♩=211 - 236 ♩=214		Pulse slows form b. 108 but then remains constant for the remainder of the piece	N/A

Figure 27. Sample of the spectrogram of Daniel Druckman's performance of Improvisation



Time:	00.0'			28.3'	29.7'	31.3	34.3'		40.8'	
Modulation Number:				1	2	3			4	
Bars:	1 - 14			15 - 16	16-17	17-18	19 - 23		24-25	
Time Signature:	4/4	5/4	4/4	3/4 - 4/4	4/4 - (2/2)	(2/2)	(2/2)	10/8	10/8 - 7/8	
Written Tempo				♪=♩=168	♩=168 (♪=84)	♩=♩=84		♩=84	♩.=♩=84 - ♩.=♩=60	
Average Performed Tempo:	♩=125			♩= 166 ♩= 126	♩=166 ♩=166	♩=166 -♩=80		♩=85	♩.=♩=90 - ♩.=♩=68	
Preparation Present?:				Y	Y	Y			N	
Section:	A									B

Figure 28. Sample of 'Audacity' image of Daniel Druckman's performance of Improvisation



Florent Jodelet Recording

The table, spectrogram (sample) and 'Audacity' analysis (sample) for Florent Jodelet's recording of *Improvisation* are shown in Figure 31, Figure 32 and Figure 33.

Florent Jodelet's recording of *Improvisation* is the most recent recording of the three analysed in this chapter, having been made in 2013. This recording sits in between Gualda's and Druckman's in terms of rhythmic accuracy; whilst Jodelet does adhere to the written rhythms (unlike Gualda), he fails to execute many of the modulations correctly as Druckman was able to. Therefore, this recording also strengthens the argument supporting the use of click tracks for Carter's *Eight Pieces for Four Timpani*. Furthermore, Jodelet's recording also supports the argument that, despite the fact that these pieces have now been recognised as "(studies) in tempo modulation"[55] and have therefore been approached as such, performers today are still challenged by their rhythmic complexities and therefore the application of click tracks is still relevant and worthwhile.

Throughout the performance, Jodelet comes in and out of time, thus performing some modulations correctly and others not. Mod. 1 is incorrect due to the fact that he begins to push the pulse tempo from b. 13, resulting in a faster pulse just prior to the modulation. As with some of Druckman's modulations, this momentum continues through the modulation, which is therefore still inaccurate regardless of context. (This process is also evident through section C and Mod. 5 in this performance). Jodelet then settles in section B, allowing for Mod. 2 to be well executed, before deviating from the set pulse again in Mod 3.due to a dragging of the quaver quintuplets. This information can be seen in the segment of the table pertaining to these modulations, as shown below in Figure 29.

Of further interest in Jodelet's performance are Mod. 8 and 9. Mod. 8 is performed contextually correct due to the fact that the pulse/tempo relationship is maintained from b. 98 – 99, allowing for an accurate realisation of the modulation. This should therefore have created a stable time system in which to perform Mod. 9. This proves not to be the case; on first inspection of the data provided Mod. 9 appears to be inaccurate. However, when studying the recording it becomes apparent that the modulation is, in a sense, contextually correct but that the acceleration of the pulse throughout the modulation has resulted in a faster average performance tempo, making the modulation appear totally incorrect, as can be seen in the table segment below. This acceleration may have been avoided through the use of a click track, which would have provided a stable pulse with which to perform the modulation, providing a cleaner result. This can be seen in Figure 30.

As is the case with the previous recording, the 'Audacity' image of Jodelet's performance provides important information regarding the rhythmic content of each bar in terms of pulses and beats present, allowing certain conclusions regarding where Jodelet deviates from the intended pulse tempo to be drawn. The acceleration of pulse in Mod 1 is also present (represented by the green and white lines which should all be evenly spaced – the white lines are noticeably closer together than the green lines). In line with this, the fact that Jodelet was able to stabilise the pulse following Mod. 1 and consequently accurately execute Mod 2 is also apparent.

These performance traits are also evident in the spectrogram of this recording (most easily visible in the red segments contained in Mod. 1 and Mod. 2). The accurate preparation and following acceleration of the pulse throughout Mod. 9 is also visible in this image, as is the stable pulse in section D, which sets up a contextually accurate performance of Mod. 6.

All three of the recordings studied in this chapter have provided interesting contrast and comparison of Carter's 'Improvisation' and have also contributed to the argument that supports the use of click tracks as a possible tool to increase the rhythmic accuracy of performances of Carter's *Eight Pieces for Four Timpani*.

[55] Schiff, *The Music of Elliott Carter*

Figure 29. Excerpt from the table of analysis of Florent Jodelet's recording of Improvisation showing Mod. 1 – 3

Section/ Modulation	Bar	Time (as per click track)	Time (recording)	Written Tempo	No. of Beats Written	No. of Beats Performed (approx.)	Average Performance Tempo	No. of Beats Contained (at written tempo)	Other Issues/ Comments	Next Mod. Given Perf. Tempo
A	1 - 14	0.04 – 0.30	0.00 –0.26	♩= 126	57	57	Range: ♩= 119 – 137 ♩= 126	56	Pulse is steady throughout this section but accelerates from b. 13	♩= 168
Mod. 1	15	0.31 – 0.32	0.26 –0.27	♩= 126	3	3	R: ♩= 159 - 163 ♩= 160	<2	Pulse accelerates during this modulation, leading to a faster pulse tempo in the next section and a slightly inaccurate performance of Mod. 1, even taking context into account	♩= 204
	16	0.32 – 0.33	0.27 –0.29	♩= 168	4	4	R: ♩= 189 - 209 ♩= 204	<3		
Mod 2.	16	0.32 – 0.33	0.27 –0.29	♩= 168	4	4	R: ♩= 189 - 209 ♩= 204	<3	The pulse tempo steadies in the modulation, allowing for an accurate performance of Mod. 2	𝅗𝅥= 102
	17	0.34 – 0.35	0.29 –0.30	♩= 168	4	4	R: ♩= 194- 211 ♩= 204	<3		

Figure 30. Excerpt from table of analysis of Florent Jodelet's recording of Improvisation showing Mod 8 – 9

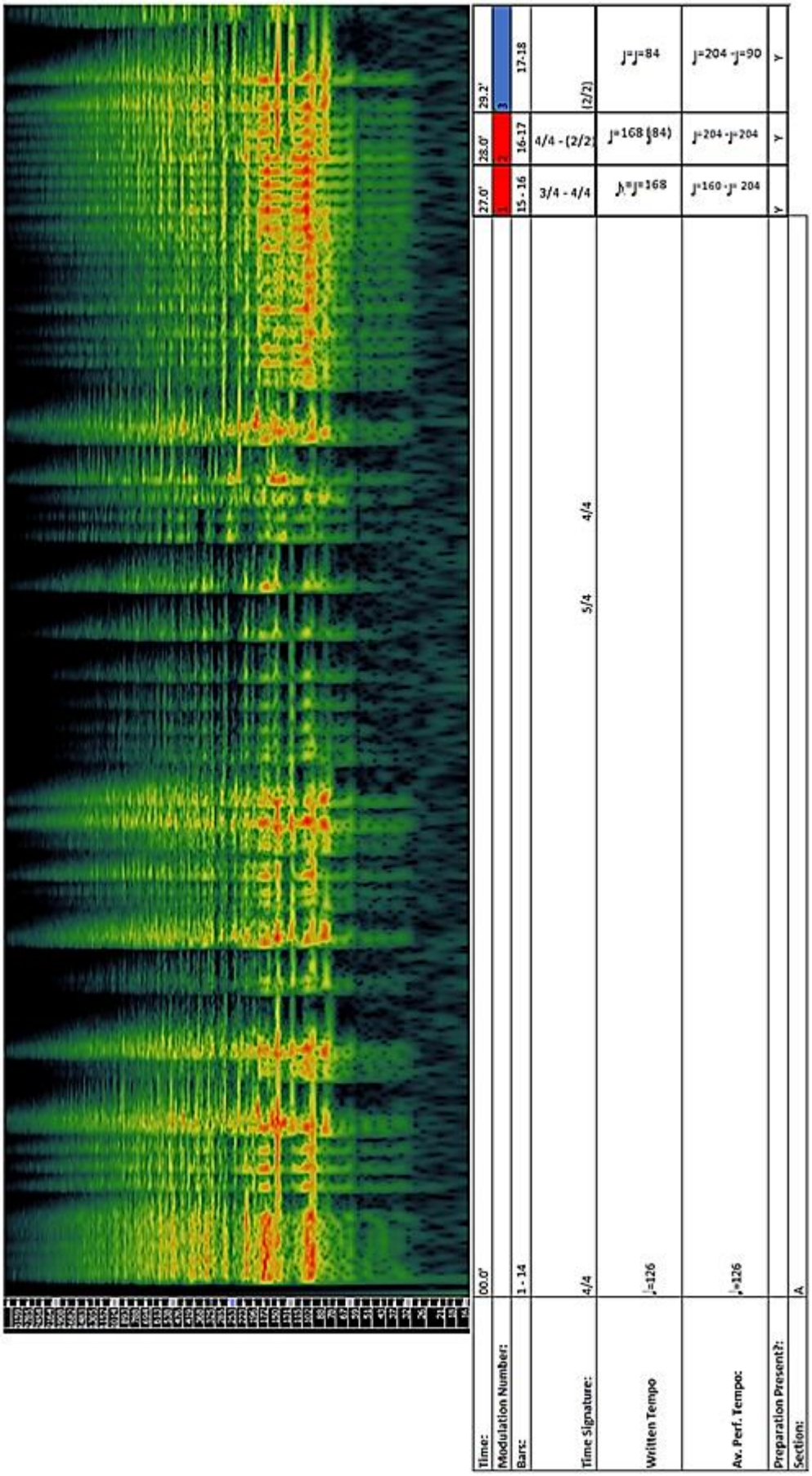
Section/ Modulation	Bar	Time (as per click track)	Time (recording)	Written Tempo	No. of Beats Written	No. of Beats Performed (approx.)	Average Performance Tempo	No. of Beats Contained (at written tempo)	Other Issues/ Comments	Next Mod. Tempo given Perf. Tempo
Mod. 8	98	2.37 – 2.38	2.14– 2.15	♩.=126	2	2	R:♩.=124 - 129 ♩.=126	2	Despite the slowing in pulse tempo in the previous section, Mod. 8 maintains a strong and settled pulse, leading to an accurate performance of b. 99 and this modulation	♩.=187.5
	99	2.38 – 2.39	2.15 – 2.16	♩.=126	2	2	R:♩.=125 - 129 ♩.=125	>2		
Mod. 9	100	2.16 – 2.17	2.29 – 2.30	♩.=126	2	2	R:♩123 - 130 ♩.=125	>3	This modulation is performed correctly but b. 3 – 4 push, accelerating the pulse tempo leading into the final section	N/A
	101	2.40 – 2.41	2.17 – 2.18	♩.=189	4	4	R:♩ = 187 - 198 ♩.=194	<5		

Figure 31. Table containing the analysis of the modulations present in Florent Jodelet's performance of Improvisation

Section/ Modulation	Bar	Time (as per click track)	Time (recording)	Written Tempo	No. of Beats Written	No. of Beats Performed (approx.)	Average Performance Tempo	No. of Beats Contained (at written tempo)	Other Issues/ Comments	Next Mod. Given Perf. Tempo
A	1 - 14	0.04 – 0.30	0.00 – 0.26	♩= 126	57	57	Range: ♩= 119 – 137 ♩= 126	56	Pulse is steady throughout this section but accelerates from b. 13	♩= 168
Mod. 1	15	0.31 – 0. 32	0.26 – 0.27	♩= 126	3	3	R: ♩= 159 - 163 ♩= 160	<2	Pulse accelerates during this modulation, leading to a faster pulse tempo in the next section and a slightly inaccurate performance of Mod. 1, even taking context into account	♩= 204
	16	0.32 – 0.33	0.27 – 0.29	♩= 168	4	4	R: ♩= 189 - 209 ♩= 204	<3		
Mod 2.	16	0.32 – 0.33	0.27 – 0.29	♩= 168	4	4	R: ♩= 189 - 209 ♩= 204	<3	The pulse tempo steadies in the modulation, allowing for an accurate performance of Mod. 2	𝅗𝅥= 102
	17	0.34 – 0.35	0.29 – 0.30	♩= 168	4	4	R: ♩= 194- 211 ♩= 204	<3		
Mod. 3	17	0.34 – 0.35	0.29 – 0.30	♩= 168	4	4	R: ♩= 194- 211 ♩= 204	<3	Pulse tempo slows here due to dragging 𝅗𝅥s. The relationship between the current pulse tempo and the pulse tempo at the start of the piece becomes stronger again here after deviating in the previous sections	𝅗𝅥.𝅗𝅥=64.2
	18	0.35 - 0.36	0.30 – 0.31	𝅗𝅥.𝅗𝅥=168 (𝅗𝅥=84)	2	2	R: 𝅗𝅥= 84 – 93 𝅗𝅥= 90	>2		
B	19 - 23	0.37 – 0.43	0.32 – 0.38	𝅗𝅥=84	10	10	R: 𝅗𝅥=81 – 91 𝅗𝅥=85	>10	The ♪ 5s drag slightly in this section, leading to a slight decrease in pulse tempo, bringing the tempo back to its written speed	N/A
Mod. 4	24	0.44 – 0.45	0.39 – 0.40	𝅗𝅥.𝅗𝅥=84	2	2	𝅗𝅥.𝅗𝅥=80 - 89 𝅗𝅥.𝅗𝅥=85	2	Mod. 4 is performed accurately	𝅗𝅥.♪=49.6
	25	0.45 – 0.46	0.40 – 0.41	𝅗𝅥.𝅗𝅥=60	1	1	R=𝅗𝅥.𝅗𝅥= 60 - 66 𝅗𝅥.𝅗𝅥=62	1		
C	26 - 39	0.47 – 1.13	0.41 – 1.03	𝅗𝅥=60	28	28	R: 𝅗𝅥=60 - 81 𝅗𝅥=74	23	Pulse tempo is quite settled until b. 31, where it is noticeably faster. It then remains at this faster tempo until b. 38, where is slows slightly	N/A

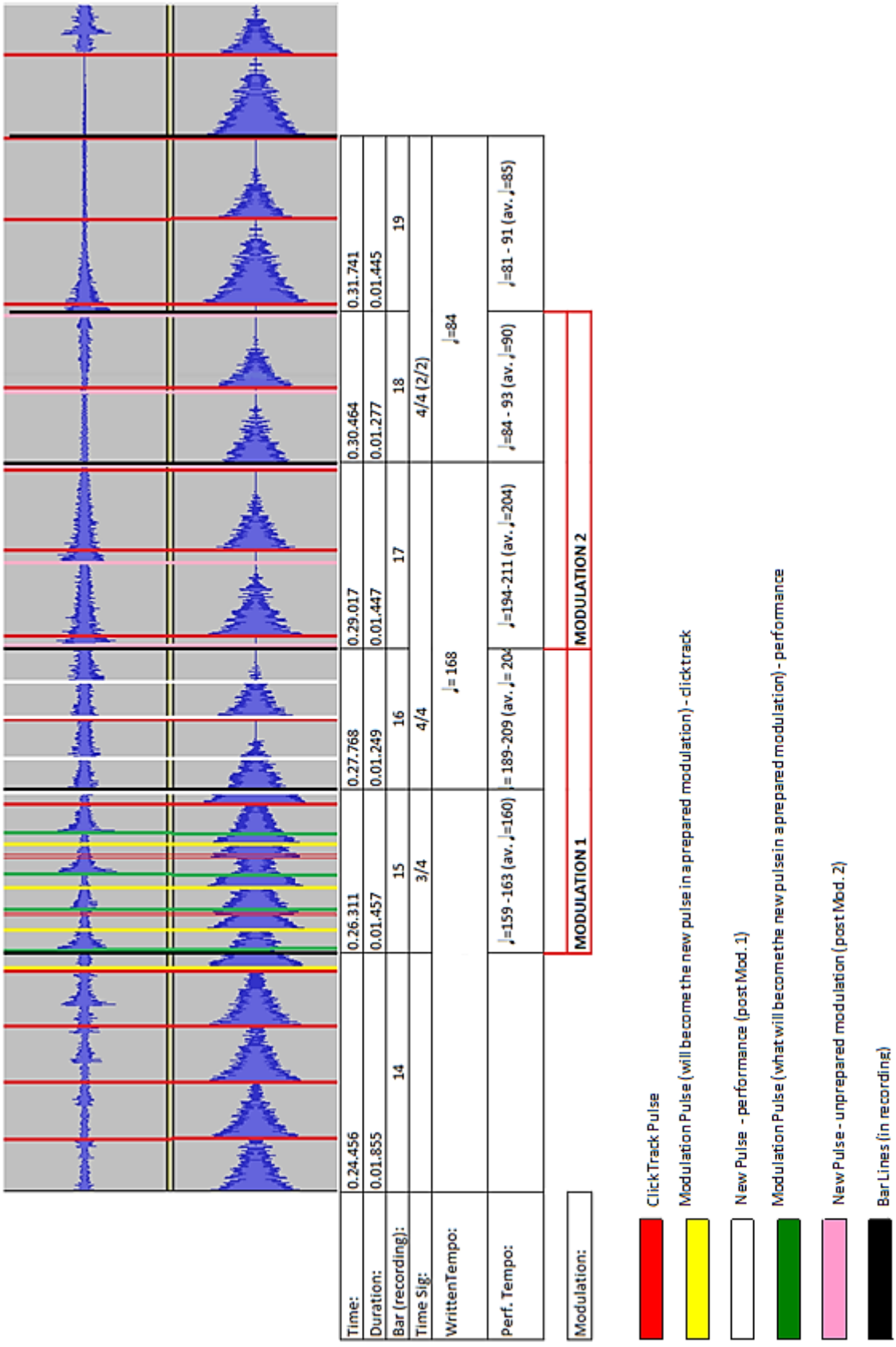
Section/ Modulation	Bar	Time (as per click track)	Time (recording)	Written Tempo	No. of Beats Written	No. of Beats Performed (approx.)	Average Performance Tempo	No. of Beats Contained (at written tempo)	Other Issues/ Comments	Next Mod. Given Perf. Tempo
Mod. 5	40	1.14 – 1.16	1.03 - 1.05	♩=120	5	5	R:♩= 134 - 140 ♩=135	3	The pulse tempo set in the previous section slightly increases during this modulation	♩=110.25
	41	1.16 – 1.17	1.06 – 1.07	♩.♪=48	2	2	R:♩.♪=59 - 64 ♩.♪=63	<1		
D	42- 45	1.18 – 1.28	1.08 – 1.15	𝅗𝅥=48	8	8	R:𝅗𝅥=60 - 66 𝅗𝅥=64	<6	Pulse remains reasonably steady here but feels as though it is pushing forward slightly, which could be due to the rhythmic accelerando	N/A
Mod. 6	46	1.29 – 1.30	1.15 – 1.16	♩=48	2	2	R:♩=60 - 62 ♩=61	<1	The pulse is kept stable here and Mod. 6 is consequently contextually correct	♩=162
	47	1.31 – 1.32	1.16 – 1.17	♩=84	2	2	R:♩=105- 113 ♩=107	<1		
E	48-70	1.33 – 1.59	1.18 – 1.42	♩=84	47	47	R:♩= 105 - 118 ♩=109	34	The pulse is maintained throughout the majority of this section, only pushing slightly in b. 61 – 64, before settling again for the rest of the section	N/A
Mod. 7	71	2.00 – 2.01	1.43 – 1.44	♩=84	2	2	R:♩= 106 - 115 ♩=110	>3	The pulse is maintained here throughout the ♩rolls, maintaining a strong sense of pulse and rhythmic accuracy	♩=165
	72	2.01 – 2.02	1.44 – 1.45	♩=126	3	3	R:♩=162 - 173 ♩=166	<2		
F	73-97	2.02 – 2.37	1.45 – 2.14	♩=126	72	72	R:♩=139 - 156 ♩= 153	62	The pulse tempo increases slightly from b. 77 but slows in the ♩ bars in this section. Pulse settles in b. 95 at a slower tempo.	N/A
Mod. 8	98	2.37 – 2.38	2.14 – 2.15	♩=126	2	2	R:♩=124 - 129 ♩=126	2	Despite the slowing in pulse tempo in the previous section, Mod. 8 maintains a strong and settled pulse tempo, leading to an accurate performance of b. 99 and this modulation	♩=187.5
	99	2.38 – 2.39	2.15 – 2.16	♩=126	2	2	R:♩= 125 - 129 ♩=125	>2		
Mod. 9	100	2.39 – 2.40	2.16 – 2.17	♩=126	2	2	R:♩=123 - 130 ♩= 125	>3	This modulation is performed correctly but beats 3 – 4 push, accelerating the pulse tempo leading into the final section.	N/A
	101	2.40 – 2.41	2.17 – 2.18	♩=189	4	4	R:♩=187 - 198 ♩=194	<5		
G	102 - 120	2.42 – 3.05	2.19 – 2.48	♩=189	76	76	R:♩=183 - 200 ♩=187	75	The pulse tempo settles from b. 103, at a slower tempo than set in Mod. 9. It then remains relatively constant throughout the remainder of the piece	N/A

Figure 32. Sample of the spectrogram of Florent Jodelet's performance of Improvisation



Time:	00.0'			27.0'	28.0'	29.2'
Modulation Number:				1	2	3
Bars:	1 - 14		15 - 16	16-17	17-18	
Time Signature:	4/4	5/4	4/4	3/4 - 4/4	4/4 - (2/2)	(2/2)
Written Tempo	♩=126			♪.=♩=168	♩=168 (♪84)	♩=♩=84
Av. Perf. Tempo:	♩=126			♩=160 - ♩= 204	♩=204 - ♩=204	♩=204 - ♩=90
Preparation Present?:				Y	Y	Y
Section:	A					

Figure 33. Sample of 'Audacity' image of Florent Jodelet's performance of Improvisation



Chapter 5

Analysis of my own Recordings of *Improvisation*

These three recordings are intended to investigate the effects that applying click tracks will have on a performance of 'Improvisation'. In order to investigate this thoroughly, the first recording is of my initial performance, prior to any influence from the click track; the second recording is with the click track present and the final recording is without the click track, but after using it in practice for two weeks. Each recording has been analysed using the same methods and tools that were used to analyse the three recordings discussed in the previous chapter.

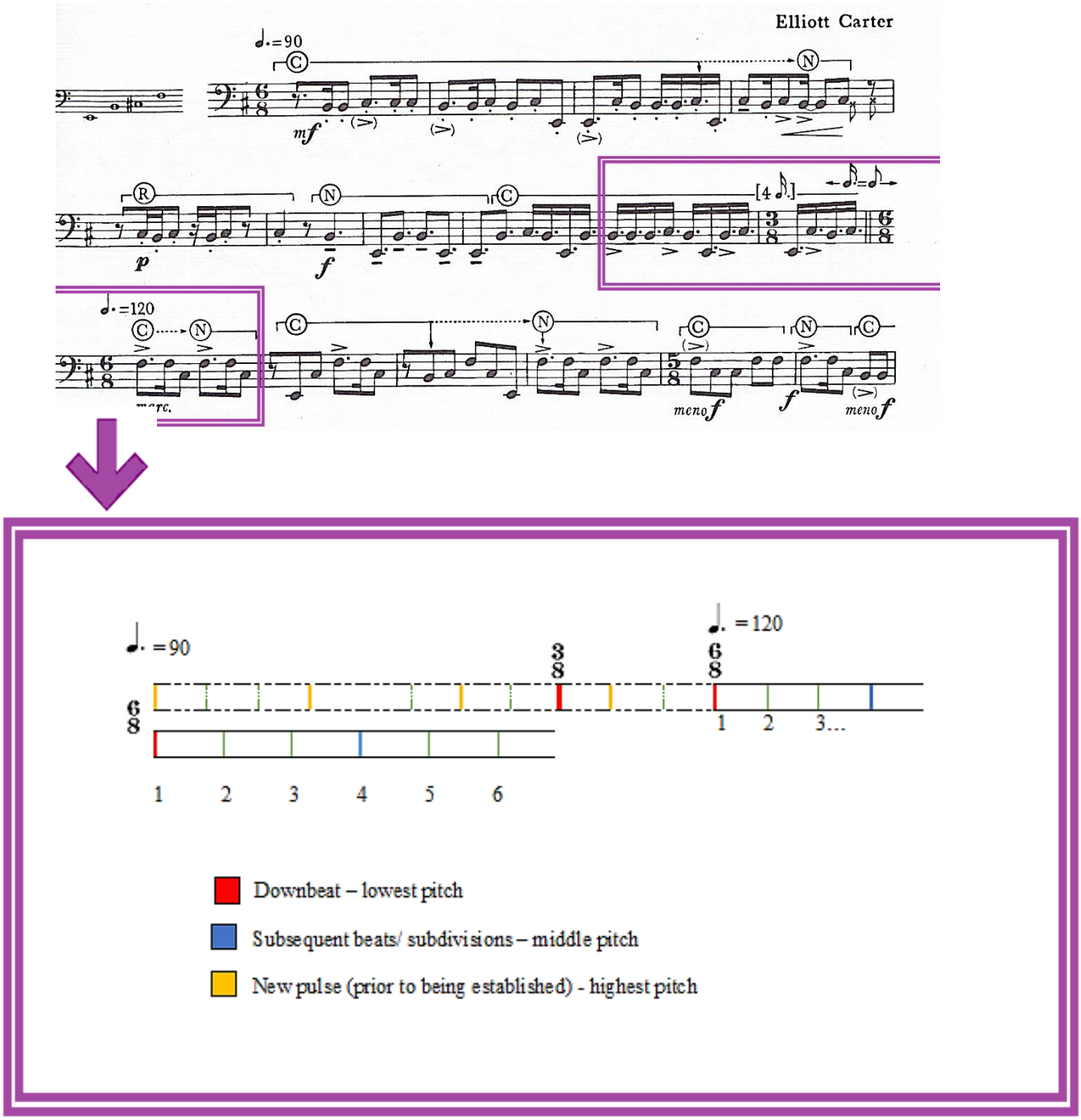
Explanation of Click Track Structure and Use

Each click track constructed for the five of Carter's *Eight Pieces for Four Timpani* that require them contains three separate pulse sounds, each representing a different parameter of the modulation/ rhythmic idea. The core sounds are a high woodblock sound, which represents the downbeat of every bar (and is also used to differentiate important grouping changes, such as in *Canaries*) and a low woodblock sound, which represents each subsequent beat in the bar. A clave sound is also present (this is the highest of the three sounds), which is used to alert the performer to an upcoming modulation by presenting the 'new' pulse prior to its occurrence, allowing the performer to focus on it. This sound also guides the performer through the modulation, assisting in maintaining the new meter and consequent time system. (This sound is also used in the same capacity with other complex rhythmic structures contained in these works.) These sounds and how they relate to one another can be seen in Figure 34 , which uses a segment of *Canaries* to demonstrate their functions. Two subdivided bars are also present at the beginning of each click track (prior to the start of the 'performance') in order to allow the performer to mentally establish the appropriate pulse tempo and time system.

One exception to the standard structure of the click tracks is *Saeta*, which contains two 'free time' bars. During these bars the click track ceases and begins again with one subdivided bar, used to alert the performer to the fact that the click track will begin again at the conclusion of the bar and that the performer should therefore conclude the 'free time' bar.

Each of the click tracks constructed as part of this dissertation have been revised several times and tested by myself on a few of the works. This testing was in an attempt to create a final product that not only accurately represents the piece concerned but is also practical and sensible in the context of a performance. All of the elements of the tracks, including the final three sounds used and what function they represent were decided based on the fact that they were the most effective during this testing.

Figure 34. Graphic representation of click track pulses during a temporal modulation in Canaries



Improvisation Initial Recording

The analysis (including table, a sample of the spectrogram and a sample of the 'audacity' image) of my initial performance of *Improvisation* is presented in Figure 37, Figure 38 and Figure 39.

My initial performance of *Improvisation* is yet another strong case to promote the use of click tracks with these works. Throughout my performance the pulse deviates from its intended tempo quite frequently, leading to inaccurate performances of the metric and temporal modulations. Of the nine modulations present in *Improvisation*, I perform only two correctly and maintain the relationship within the bars of the modulation on two other occasions (making these modulations correct to a limited extent).

From the beginning of the performance I never truly establish a stable pulse – it begins too fast and fluctuates frequently throughout section A, decreasing in tempo in the two bars prior to the first modulation, which is inaccurate as a consequence. The pulse tempo does settle post- Mod. 1 and Mod. 2 is therefore able to be executed well. This is evident in the table segment shown in Figure 35 below:

Figure 35. Excerpt from table of analysis if my initial recording of Improvisation showing Mod. 1 - 2

Section/ Modulation No.	Bar	Time (as per click track)	Time (recording)	Written Tempo	No. of Beats Written	Performance Tempo Range	Av. Performance Tempo	No. of Beats Contained	Other Issues/ Comments	Next Mod. Given inaccuracy
Mod. 1	15	0.31 – 0. 32	0.28 – 0.29	𝅗𝅥= 126	3	𝅗𝅥=104 -108	𝅗𝅥=107	3	Mod.1 is performed slightly under tempo compared to the predicted tempo given the errors in b. 13- 15.	𝅗𝅥=68.5
	16	0.32 – 0.33	0.30 – 0.31	𝅗𝅥 = 168	4	𝅗𝅥 = 136-142	𝅗𝅥 = 137	5		
Mod. 2	16	0.32 – 0.33	0.31 – 0.32	𝅗𝅥 = 168	4	𝅗𝅥 = 136-142	𝅗𝅥 = 137	5	Mod. 2 is performed rather correctly given the tempo established after Mod 1.	𝅗𝅥=70
	17	0.34 – 0.35	0.33 – 0.34	𝅗𝅥=168 (𝅗𝅥=84)	2	𝅗𝅥=68-72	𝅗𝅥=70	2.5		(𝅘𝅥𝅯)₅=350)

As was the case with Gualda's and Druckman's recordings, I struggle to perform the quaver quintuplets present in section B; I rush through these rhythmic structures, causing the pulse tempo to accelerate. This inaccurate realisation of the tuplets contained in this section is a trend of this performance – it occurs again in Mod.4 (where they are slower than the set tempo) and Mod. 5 (where they are performed faster than intended). Another common issue in my initial performance of 'Improvisation' is the shortening and lengthening of the rests indicated. I often clip rests short in this performance, as is the case in sections B and F and Mod. 8 and 9. This results in an increase in pulse tempo, making it more difficult to execute the subsequent sections correctly.

Mod. 6 and 8 are the two modulations in this recording in which the pulse or subdivision relationship is maintained, despite the modulation not commencing at the tempo set in the preceding section. In Mod. 6 the pulse tempo between Mod.5 and section D decreases, meaning that Mod. 6 will not be performed at the tempo intended and will therefore not result in the predicted new pulse tempo. However, the pulse is manipulated in the correct manner within the modulation, increasing to a ratio of 7:4. The modulation is therefore said to be 'contextually correct'. This information is shown in the table in Figure 36 below:

Figure 36. Excerpt from table of analysis of my initial recording of Improvisation showing Mod 5 - 6

Section/ Modulation No.	Bar	Time (as per click track)	Tempo (recording)	Written Tempo	No. of Beats Written	Performance Tempo Range	Average Performance Tempo	No. of Beats Contained	Other Issues/ Comments	Next Mod. Given inaccuracy
C	26 - 39	0.47 – 1.13	0.44 – 1.07	𝅗𝅥=60	28	𝅗𝅥=60 - 71	𝅗𝅥=63	26	Rests are shortened in places leading to some metronomic spikes in tempo, despite the low average tempo.	N/A
Mod. 5	40	1.14 – 1.16	1.08 – 1.09	♩=120	5	♩=137-142	♩=139	4.5	The tempo accelerates from b. 37 due to rushed 𝅘𝅥𝅯s and a rushed ♩ triplet. b. 39 also pushes the tempo. The tempo settles from b. 42 to 𝅗𝅥=~62	♩=120.75
	41	1.16 – 1.17	1.09 – 1.10	♩𝅘𝅥𝅯=48	2	♩𝅘𝅥𝅯=66 - 80	♩𝅘𝅥𝅯=69	<1.5		
D	42- 45	1.18 – 1.28	1.11 – 1.19	𝅗𝅥=48	8	𝅗𝅥=60 - 65	𝅗𝅥=62	<6.5	Tempo stays constant throughout this section for the first time in the recording.	N/A
Mod. 6	46	1.29 – 1.30	1.19 – 1.20	♩=48	2	♩=62- 66	♩=65	1.5	Tempo pushes slightly in b. 45. But otherwise is steady. This steady tempo allows for a relatively accurate performance of Mod. 6.	♩=165
	47	1.31 – 1.32	1.20 – 1.21	♩=84	2	♩=108 - 114	♩=110	<1.5		

A similar situation is discovered when studying Mod. 8; the pulse from section F is unable to be taken into this modulation due to its extreme instability and as such, Mod. 8 begins at a somewhat unrelated tempo. However, this set pulse is maintained reasonably well, not only resulting in a correct manipulation of the pulse through Mod. 8 but also an accurate realisation of Mod. 9.

Of particular interest when studying the 'Audacity' image of my initial recording is the bars 13 – 18. From bar 13, the decrease in pulse tempo is evident by the placement of the bar lines in comparison to how many click track pulses the bars actually contain. Following these bars, the slower pulse contained in Mod. 1 is discernable by the difference in spacing between the yellow lines (representing the 'new' pulse played by the click track) and the green lines (showing this new pulse as it was performed). The subsequent section brings to light the fact that the pulse stabilised (the green lines and white lines, which represent the same pulse, are evenly spaced) and that therefore Mod. 2 was performed reasonably accurately (the pink lines representing the unprepared pulse set through Mod 2 are also evenly spaced). This image also portrays similar characteristics as the other 'Audacity' images previously discussed in this paper do regarding points in the performance where the pulse deviates from its intended tempo.

The spectrogram of this recording also demonstrates some interesting rhythmic traits of the performance. The section containing bars 13 – 18 reinforces the information present in the 'Audacity' image regarding the manipulation of pulse in Mod. 1 and 2. The consistent tempo throughout Mod. 5 and section D is also visible.

The recording of my initial performance of *Improvisation* provides a typical example of a student's interpretation of not only this piece but the other pieces contained in Carter's *Eight Pieces for Four Timpani*. Many students often struggle to master the modulations and other complex rhythms in these works. Furthermore, once a rhythmic error has been made, students find it difficult to adjust accordingly so as to perform the rest of the piece accurately; this coupled with the successive modulations that are present in many of these timpani pieces results in an increasing gap between what is performed and what is written and often makes it difficult to perform sections of each piece (i.e. if the pulse is accelerated accidentally some rhythms are too fast to execute with precision). These qualities are evident in my recording by the fact that successive modulations are incorrect, indicating an inability to adjust to any errors that have occurred. The application of a click track would undoubtedly assist with this issue.

Figure 37. Table containing the analysis of the modulations present in my initial performance of Improvisation

Section/ Modulation No.	Bar	Time (as per click track)	Time (recording)	Written Tempo	No. of Beats Written *	Performance Tempo Range	Average Performance Tempo	No. of Beats Contained (at written tempo)	Other Issues/ Comments	Next Mod. Given inaccuracy
A	1-14	0.04 – 0.30	0.01 – 0.27	♩= 126	57	♩=116 - 131	♩ = 127	48	Tempo starts too fast (♩ =131), then settles at~ ♩ = 127 by b. 3. Tempo decreases slightly in b. 4 -7 Tempo settles again at b. 8 (~♩ = 127) Tempo decreases slightly in b. 13-15	♩= 165.3
Mod. 1	15	0.31 – 0. 32	0.28 – 0.29	♩= 126	3	♩=104 -108	♩=107	3	Mod.1 is performed slightly under tempo compared to the predicted tempo given the errors in b. 13- 15.	𝅗𝅥=68.5
	16	0.32 – 0.33	0.30 – 0.31	♩= 168	4	♩= 136-142	♩ = 137	5		
Mod. 2	16	0.32 – 0.33	0.31 – 0.32	♩ = 168	4	♩ = 136-142	♩ = 141	5	Mod. 2 is performed rather correctly given the tempo established after Mod 1.	𝅗𝅥=70 (𝅘𝅥𝅯𝅘𝅥𝅯𝅘𝅥𝅯=350)
	17	0.34 – 0.35	0.33 – 0.34	♩=168 (♩=84)	2	𝅗𝅥=68-72	♩ =70	2.5		
Mod. 3	17	0.34 – 0.35	0.35 – 0.36	♩=168 (♩ =84)	2	𝅗𝅥=68-72	♩ =70	2.5	The pulse is accelerated due to rushing the ♪ 5s in b. 18 – 19. This actually means I have more-or-less re-established the written tempo.	♩.♩=60.7
	18	0.35 - 0.36	0.36 – 0.37	𝅗𝅥=84	2	♩ =84-89	♩ =85 (𝅘𝅥𝅯𝅘𝅥𝅯=425)	2		
B	19 - 23	0.37 – 0.43	0.37 – 0.41	♩ =84	10	♩ =79- 87	♩ =84	10	The pulse is slightly inconsistent due to rushing the ♪5s and inaccurate rests.	N/A
Mod. 4	24	0.44 – 0.45	0.42 – 0.43	♩.♩=84	2	♩.♩=78- 84	♩.♩=82	2	This modulation is performed a little faster than written, largely due to the rushing ♪ 5s in section B. The ♪ 7s in b. 26-29 settle and slow slightly to 𝅗𝅥=~ 62 (close to written tempo.)	♩.♪=52
	25	0.45 – 0.46	0.43 - 0.44	♩.♩=60	1	♩.♩ =64-69	♩.♩ =65	>1		
C	26 - 39	0.47 – 1.13	0.44 – 1.07	♩ =60	28	♩ =60 - 71	♩ =63	26	Rests are shortened in places leading to some metronomic spikes in tempo, despite the low average tempo.	N/A
Mod. 5	40	1.14 – 1.16	1.08 – 1.09	♩=120	5	♩ =137-142	♩ =139	4.5	The tempo accelerates from b. 37 due to rushed ♪s and a rushed ♩ triplet. b. 39 also pushes the tempo. The tempo settles from b. 42 to 𝅗𝅥=~62	♩ =120.75
	41	1.16 – 1.17	1.09 – 1.10	♩.♪=48	2	♩.♪ =66 - 80	♩.♪ =69	<1.5		

Section/ Modulation No.	Bar	Time (as per click track)	Time (recording)	Written Tempo	No. of Beats Written *	Performance Tempo Range	Average Performance Tempo	No. of Beats Contained (at written tempo)	Other Issues/ Comments	Next Mod. Given inaccuracy
D	42- 45	1.18 – 1.28	1.11 – 1.19	𝅗𝅥=48	8	𝅗𝅥=60 - 65	𝅗𝅥=62	<6.5	Tempo stays constant throughout this section for the first time in the recording.	N/A
Mod. 6	46	1.29 – 1.30	1.19 – 1.20	♩=48	2	♩=62- 66	♩=65	1.5	Tempo pushes slightly in b. 45. But otherwise is steady. This steady tempo allows for a relatively accurate performance of Mod. 6.	♩=165
	47	1.31 – 1.32	1.20 – 1.21	♩=84	2	♩=108 - 114	♩=110	<1.5		
E	48-70	1.33 – 1.59	1.22 - 1.42	♩=84	47	♩=110 - 145	♩=126	29	The 𝅗𝅥s were always cut short from b.65, leading to an accelerando. The tempo settles at b. 67 at ♩=~117.	N/A
Mod. 7	71	2.00 – 2.01	1.42 – 1.43	♩=84	2	♩=112 - 118	♩=116	>1.5	Change of pulse from 2 in a bar to 3 accelerates in b. 73, increasing the tempo.	♩=203
	72	2.01 – 2.02	1.43 – 1.44	♩=126	3	♩=198 - 210	♩=203	>1.5		
F	73-97	2.02 – 2.37	1.45 – 2.08	♩=126	72	♩=60-115	=???	49	Shortened rests and clipped rhythms make the pulse hard to find in this section. Incorrect rhythm in b.77 Pulse settles at b. 95 to =♩~135	N/A
Mod. 8	98	2.37 – 2.38	2.08– 2.09	♩=126	2	♩=139 - 55	♩=144	<1	The rests in b. 99 are cut very short, leading to a metronomic spike in tempo by b. 100 and an incorrect performance of Mod. 8.	♩=220.5
	99	2.38 – 2.39	2.09 – 2.10	♩=126	2	♩=144- 49	♩=147	<1		
Mod. 9	100	2.39 – 2.40	2.10 – 2.11	♩=126	2	♩=217 - 223	♩=220	>1	Modulation 9 is performed very accurately despite the shortened rests in b.99. Tempo remains relatively steady at b. 101 as well.	N/A
	101	2.40 – 2.41	2.11 - 2.12	♩=189	4	♩=221 - 236	♩=223	<4.5		
G	102 - 120	2.42 – 3.05	2.13 – 2.34	♩=189	76	♩=225 - 236	♩=229	68	Pulse stays quite steady throughout the remainder of the piece. It does become slightly unstable in b. 106-107 and b. 113- 114.	N/A

* All beats are performed in this recording

Figure 38. Sample of the spectrogram of my initial performance of Improvisation

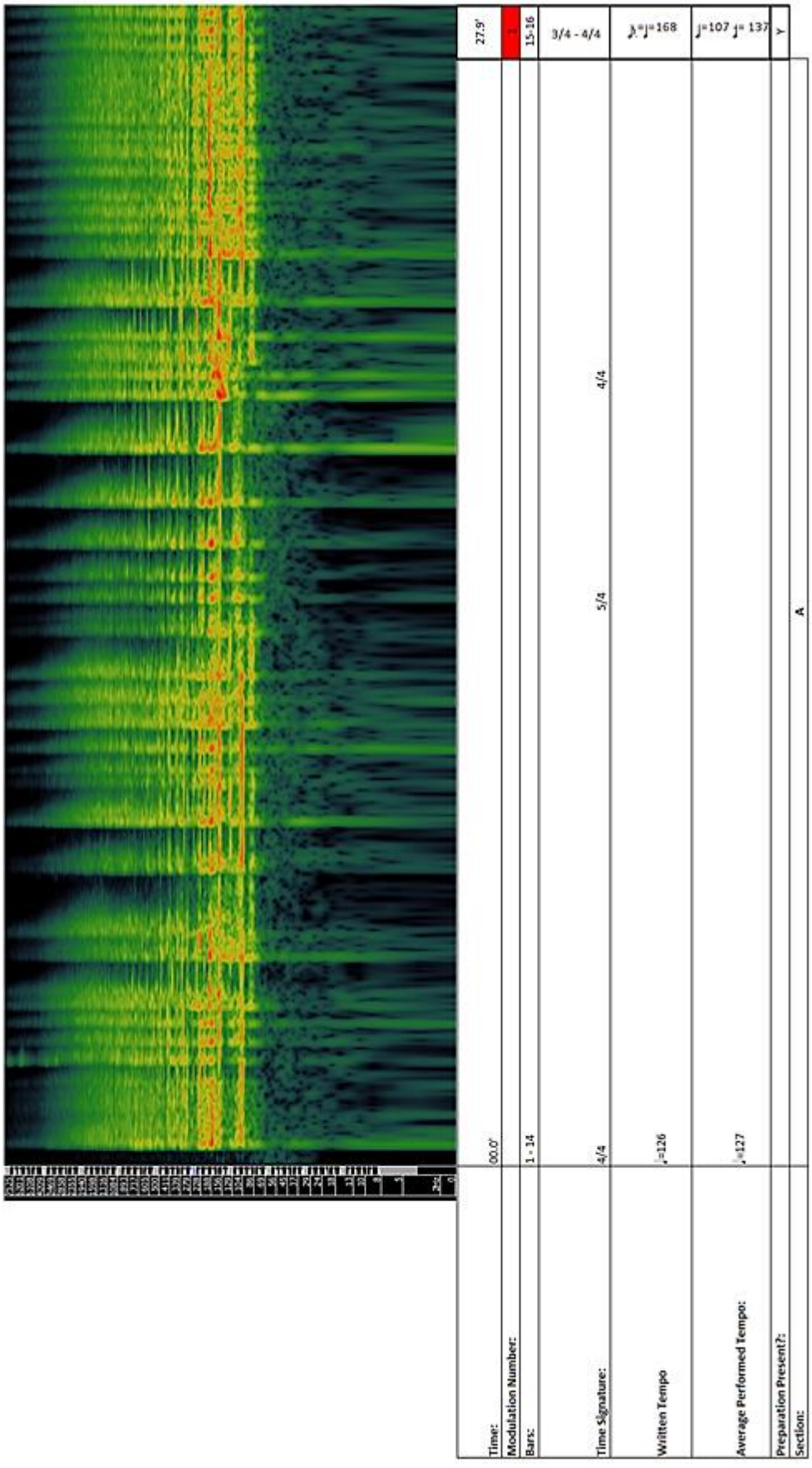
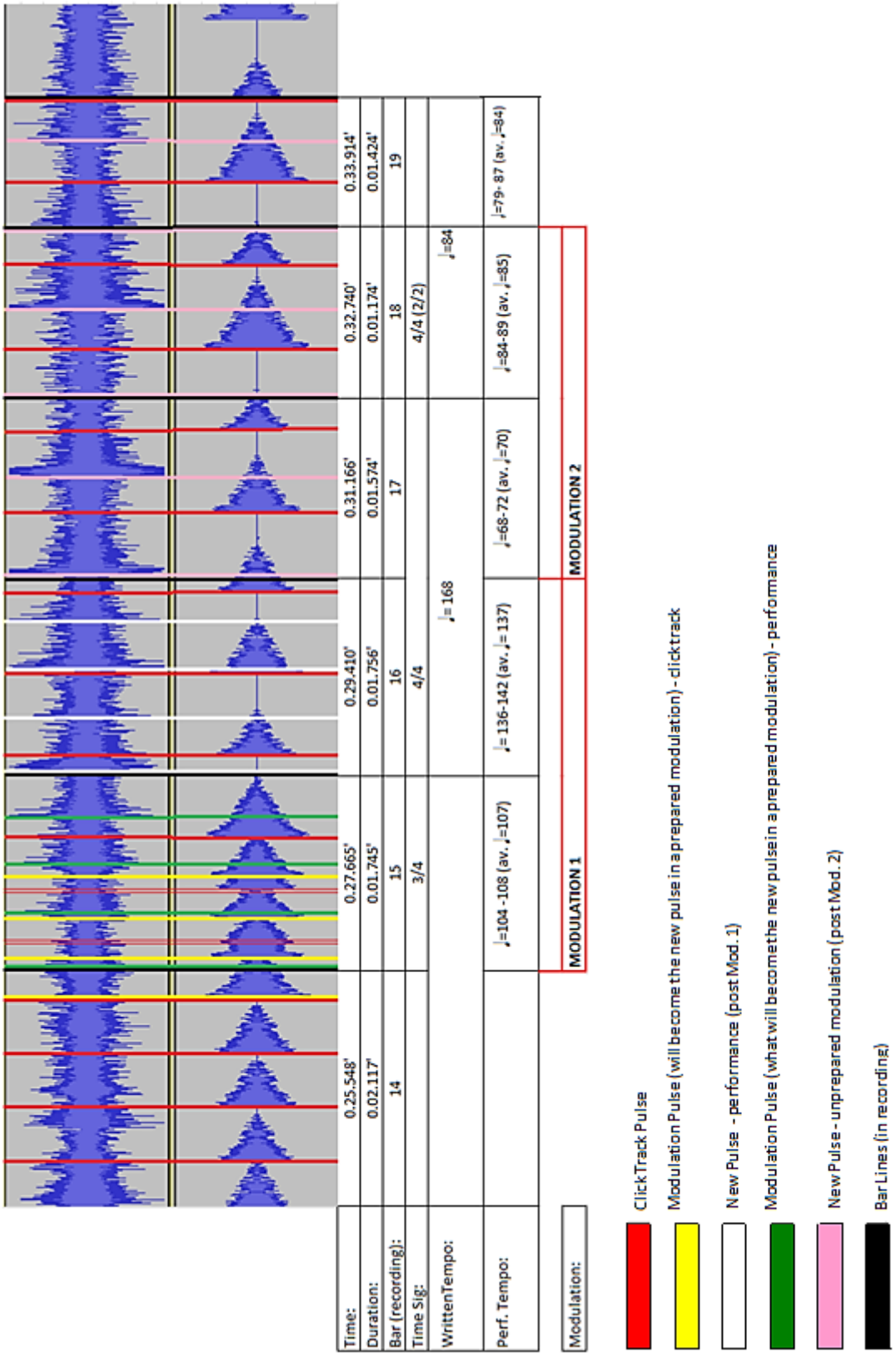


Figure 39. Sample of 'Audacity' image of my initial performance of Improvisation



Improvisation Recording with Click Track

The table, spectrogram sample and 'Audacity' image sample presenting the analysis of this recording are contained in Figure 42, Figure 43 and Figure 44 respectively.

My second recording of *Improvisation* is of a performance throughout which the click track is constantly present, always influencing my playing and assisting in the creation of a stable time system. This influence results in drastic changes to the rhythmic accuracy of my performance and my ability to execute the metric and temporal modulations throughout the piece.

I being my performance at the exact written tempo and although the pulse does fluctuate at times throughout some sections, I am able to regain control of the pulse with the assistance of the click track. As a result of this, Mod.1 through 4 are performed correctly at the written tempo, a trait which none of the recordings discussed so far in this dissertation have had. The first significant rhythmic error occurs in section C, with the shortening of a rest in b. 31and a consequent increase in pulse tempo. The tempo settles throughout the following nine bars of the section, almost returning to the written tempo upon arrival at Mod. 5, which is still performed accurately. This can be seen in the table excerpt in Figure 40 below:

Figure 40. Excerpt from table of analysis of my recording of Improvisation with the click track showing section C - Mod 5

Section/ Modulation No.	Bar	Time (as per click track)	Time (recording)	Written Tempo	No. of Beats Written	Performance Tempo Range	Average Performance Tempo	No. of Beats Contained	Other Issues/ Comments	Next Mod. Given inaccuracy
C	26 - 39	0.47-1.13	0.46 – 1.12	𝅗𝅥=60	28	𝅗𝅥=59 - 61	𝅗𝅥=60	>28	Some rhythms in this section rush (ie. the 𝅘𝅥𝅯7s in b.34 and the 𝅘𝅥𝅯s in b. 37) but the pulse is stabilised by the presence of the click track, allowing for an accurate av. perf. tempo	N/A
Mod. 5	40	1.14-1.16	1.13 – 1.15	♩=120	5	♩=116 - 123	♩=120	5	Mod. 5 is performed accurately The highest pulse sound assists in keeping the 𝅘𝅥𝅯s stable, thus creating a stable pulse	♩=84
	41	1.16-1.17	1.15 – 1.17	♩𝅘𝅥𝅯 =48	2	♩𝅘𝅥𝅯 =47 - 50	♩𝅘𝅥𝅯 =48	2		

This ability to return to the original tempo is arguably largely due to the presence of the click track. The first modulation to be performed inaccurately is Mod. 6; this is due to an increase in pulse tempo through section D (which contains the rhythmically accelerating tuplets - a rhythm which, by nature, is prone to pushing the pulse tempo) which carries through Mod. 6. However, the pulse then stabilises in section E, allowing for a contextually accurate performance of Mod 7. This again becomes evident when studying the information presented in the table, a segment of which is shown in Figure 41 below:

Figure 41. Excerpt from table of analysis of my recording of Improvisation with the click track showing section D - E

Section/ Modulation No.	Bar	Time (as per click track)	Time (recording)	Written Tempo	No. of Beats Written	Performance Tempo Range	Average Performance Tempo	No. of Beats Contained	Other Issues/ Comments	Next Mod. Given inaccuracy
D	42- 45	1.18 – 1.28	1.18 – 1.28	𝅗𝅥=48	8	𝅗𝅥=46 - 50	𝅗𝅥=48	8	The highest pulse sound present in the click track keeps the tuplets accurate, allowing for a clean and accurate rhythmic acceleration	N/A
Mod. 6	46	1.29 – 1.30	1.28 – 1.29	♩.=48	2	♩.=48 - 50	♩.=48	2	Mod. 6 is accurate and the pulse remains steady	♩=126
	47	1.31 – 1.32	1.29 – 1.30	♩=84	2	♩=83 - 84	♩=84	2		
E	48-70	1.33 – 1.59	1.30 – 1.59	♩=84	47	♩=84 - 96	♩=90	41	The 𝅘𝅥𝅯s at the beginning of this section rush slightly, setting up a faster pulse tempo. Some rolls in this section also rush, creating a slightly unstable pulse	♩=135

The rest of the modulations follow suit, being performed contextually correctly. My inability to adhere to the click track from Mod. 6 onwards and therefore return to the written tempo could be due to the increased rhythmic activity, rhythmic difficulty and overall volume of the performance, making it harder to hear the track. Regardless of this, the improvement compared to my initial recording is definitely apparent.

This increase in rhythmic accuracy is reinforced by both the spectrogram and 'Audacity' image. The 'Audacity' image demonstrates the increased tightness of the performance as well as the moments in which the pulse deviates from the click, only to be brought back by the click track (such as is visible in b. 13 - 14). The accuracy of my modulations compared to those presented through the 'Audacity' images of the other recordings analysed is also evident.

The spectrogram of this recording also demonstrates the overall stability of the pulse throughout this performance. This is particularly clear in the section containing Mod. 1 – Mod. 3 and Mod. 5. The spectrogram also reinforces the fact that, whilst some of the later modulations are not adhering to the click track, they are still 'contextually correct' (Mod. 7 and 9 are examples of this).

Figure 42. Table containing the analysis of the modulations present in my performance of Improvisation with the click track

Section/ Mod. No.	Bar	Time (as per click track)	Time (recording)	Written Tempo	No. of Beats Written *	Performance Tempo Range	Average Performance Tempo	No. of Beats Contained (at written tempo)	Other Issues/ Comments	Next Mod. Given inaccuracy
A	1-14	0.04 – 0.30	0.03 – 0.30	♩= 126	57	♩=122 - 129	♩= 126	57	Pulse remains very stable until b. 13, where the 𝅘𝅥𝅯waver from the click track slightly. Mod. 1 should be performed accurately	♩= 168
Mod. 1	15	0.31 – 0. 32	0.31 – 0. 32	♩= 126	3	♩=125 -129	♩=126	3	Mod. 1 is performed correctly with the assistance of the highest pulse present in the click track	𝅗𝅥=84
	16	0.32 – 0.33	0.32 – 0.33	♩= 168	4	♩= 166 -168	♩ = 168	4		
Mod. 2	16	0.32 – 0.33	0.32 – 0.33	♩= 168	4	♩= 166 -168	♩= 168	4	Mod. 2 is fairly accurate – rather than separating from the click track, the pulse 'sits forward' on the beat. The click track prevents rushing from occurring	♩=86 (𝅘𝅥𝅰𝅘𝅥𝅰=430)
	17	0.34 – 0.35	0.33 – 0.35	♩=168 (𝅗𝅥=84)	2	♩=83 - 89	♩=86	>2		
Mod. 3	17	0.34 – 0.35	0.33 – 0.35	♩=168 (𝅗𝅥=84)	2	♩=83 - 89	♩=86	>2	Mod. 3 is also performed accurately. The click track assists in the pulse returning to the written and intended tempo. The 𝅘𝅥𝅯5s sit back in the beat in order for this to occur	♩𝅘𝅥𝅯=60
	18	0.35 - 0.36	0.35 – 0.36	♩=84	2	♩=81 - 86	♩=84 (𝅘𝅥𝅰𝅘𝅥𝅰=420)	2		
B	19 - 23	0.37 – 0.43	0.36 – 0.43	♩=84	10	♩=83 - 86	♩=84	10	Pulse remains stable throughout this section	N/A
Mod. 4	24	0.44 – 0.45	0.44 – 0.45	♩𝅘𝅥𝅯=84	2	♩𝅘𝅥𝅯=83 - 86	♩𝅘𝅥𝅯=84	2	Mod. 4 is performed correctly and the pulse remains very stable	♩𝅘𝅥𝅯=48
	25	0.45 – 0.46	0.45 – 0.46	♩𝅘𝅥𝅯=60	1	♩𝅘𝅥𝅯=59 - 62	♩𝅘𝅥𝅯=60	1		
C	26 - 39	0.47 – 1.13	0.46 – 1.12	♩=60	28	♩=59 - 61	♩=60	>28	Some rhythms in this section rush (ie. the 𝅘𝅥𝅯7s in b.34 and the 𝅘𝅥𝅯s in b. 37) but the pulse is stabilised by the presence of the click track, allowing for an accurate av. perf. tempo	N/A
Mod. 5	40	1.14 – 1.16	1.13 – 1.15	𝅗𝅥=120	5	♩=116 - 123	♩=120	5	Mod. 5 is performed accurately The highest pulse sound assists in keeping the 𝅘𝅥𝅯s stable, thus	♩=84
	41	1.16 – 1.17	1.15 – 1.17	♩𝅘𝅥𝅯 =48	2	♩𝅘𝅥𝅯 =47 - 50	♩𝅘𝅥𝅯 =48	2		

Section/ Modulation No.	Bar	Time (as per click track)	Time (recording)	Written Tempo	No. of Beats Written	Performance Tempo Range	Average Performance Tempo	No. of Beats Contained	Other Issues/ Comments	Next Mod. Given inaccuracy
D	42- 45	1.18 – 1.28	1.18 – 1.28	♩=48	8	♩=46 - 50	♩=48	8	The highest pulse sound present in the click track keeps the tuplets accurate, allowing for a clean and accurate rhythmic acceleration	N/A
Mod. 6	46	1.29 – 1.30	1.28 – 1.29	♩.=48	2	♩.=48 - 50	♩.=48	2	Mod. 6 is accurate and the pulse remains steady	♩=126
	47	1.31 – 1.32	1.29 – 1.30	♩=84	2	♩=83 - 84	♩=84	2		
E	48-70	1.33 – 1.59	1.30 – 1.59	♩=84	47	♩=84 - 96	♩=90	41	The 𝅘𝅥𝅯s at the beginning of this section rush slightly, setting up a faster pulse tempo. Some rolls in this section also rush, creating a slightly unstable pulse	♩=135
Mod. 7	71	2.00 – 2.01	1.59 – 2.01	♩=84	2	♩=81 - 87	♩=85	>2	This modulation is not performed contextually correct. However, it is performed correctly in term of written tempo – the click track stabilised the pulse tempo, bringing it back to the intended tempo	♩=126
	72	2.01 – 2.02	2.01 – 2.02	♩=126	3	♩=124 - 127	♩=126	3		
F	73-97	2.02 – 2.37	2.02 – 2.37	♩=126	72	♩=120 - 133	♩=126	>72	Whilst some rhythms in this section waver from the click track, the track assists in maintaining a relatively stable pulse	♩=126
Mod. 8	98	2.37 – 2.38	2.36 – 2.37	♩=126	2	♩.=124 - 126	♩.=126	2	The click track assists in keeping the pulse very constant in b. 98 and then ensuring the proper rest length is observed in b. 99, leading to an accurate performance of Mod. 8	♩=189
	99	2.38 – 2.39	2.37 – 2.38	♩=126	2	♩.=126	♩.=126	2		
Mod. 9	100	2.39 – 2.40	2.38 – 2.39	♩.=126	2	♩.=125 - 128	♩.=127	>2	The pulse pushes slightly in this modulation, which is still accurate. However, assisted by the presence of the click track, it settles in the beginning of the final section of the piece	♩=190
	101	2.40 – 2.41	2.39 – 2.40	♩=189	4	♩=188 - 192	♩=190	>4		
G	102 -120	2.42 – 3.05	2.40 – 3.04	♩=189	76	♩=181 - 211	♩=190	>76	The pulse pushes quite a few times in this section but is usually brought back to the intended tempo by the click track	N/A

* All beats are performed in this recording

Figure 43. Sample of the spectrogram of my performance of Improvisation with the click track

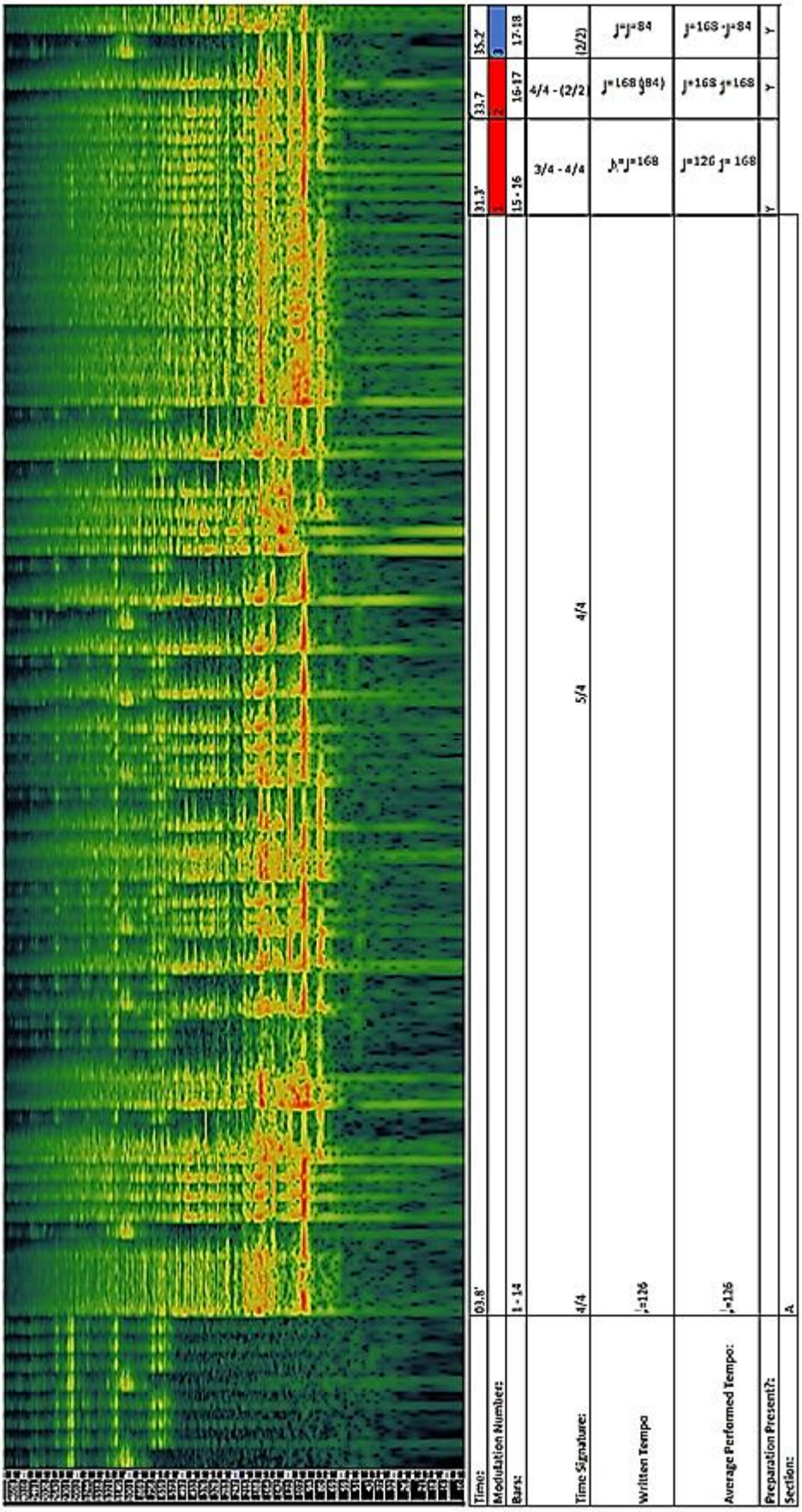
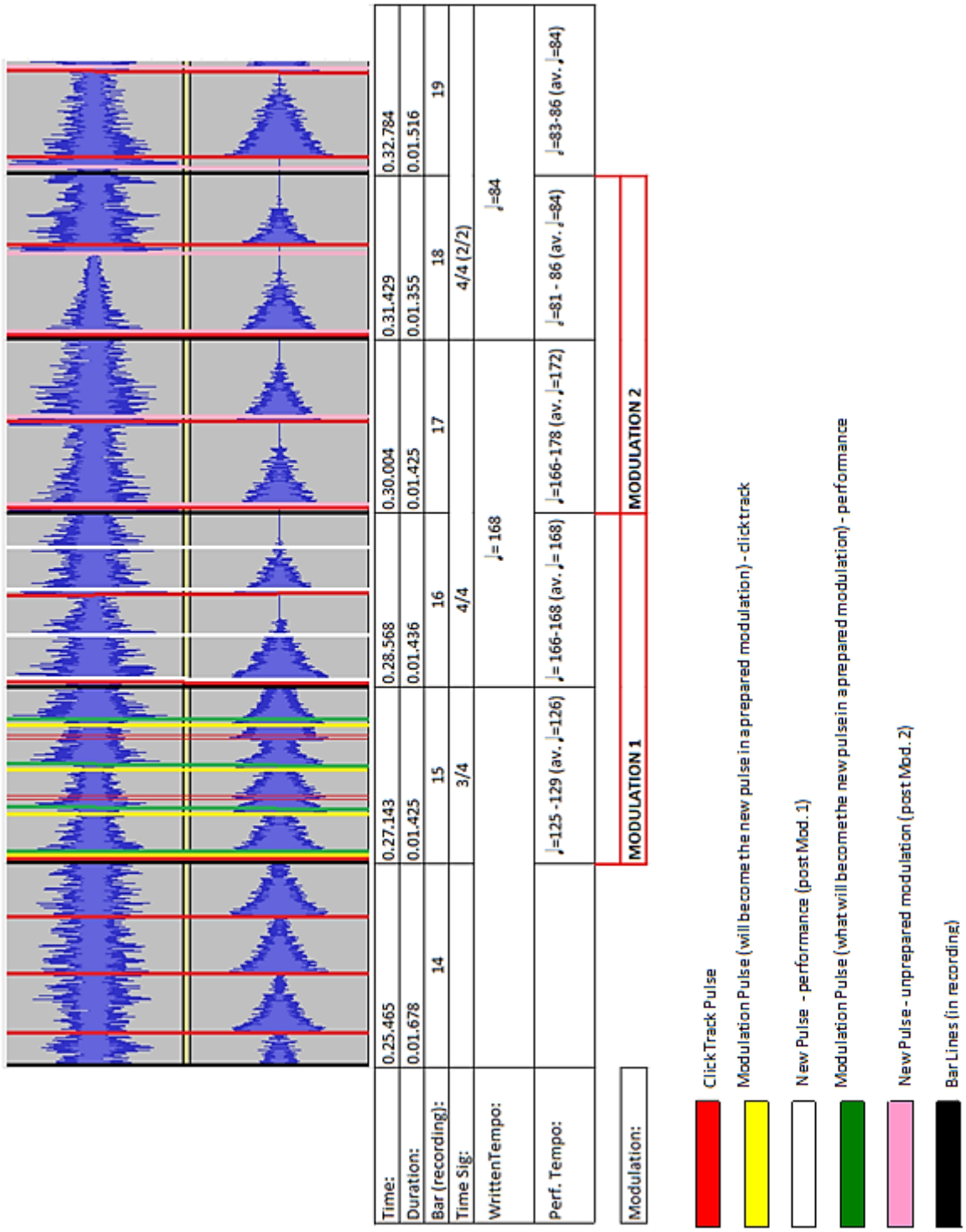


Figure 44. Sample of the 'Audacity' image of my recording of Improvisation with the click track



Improvisation Final Recording

The analysis of my final recording of *Improvisation* (including table, spectrogram sample and 'Audacity' image sample) are contained in Figure 47, Figure 48 and Figure 49.

My final recording was made after spending approximately two weeks practicing with the click track then recorded without the click track being present, thus allowing comparisons between this recording and my initial recording of *Improvisation* to be made. Prior to the start of the performance, the two subdivided bars present at the beginning of the click track were played in order to set the pulse and create the appropriate time system.

The difference between my initial recording and this recording in terms of rhythmic accuracy is remarkable. My initial recording contained a number of rhythmic issues and five incorrect modulations (of the other modulations, two were accurate and connected to the previous section and two were 'contextually correct'); my final recording contains five modulations which are performed correctly and at the written tempo, three modulations which are 'contextually correct' and only one modulation which is executed inaccurately. Furthermore, the pulse is far more stable overall throughout the performance, with the rhythmic clarity and precision improved as a consequence.

Throughout the first four modulations and the sections separating them the pulse remains constant and each modulation is executed well. Mod. 3 was particularly successful; the quaver quintuplets contained in the modulation have proven to be problematic to both myself and the other performers studied in this dissertation. However, in this recording they 'sit' well within the pulse and feel settled and stable. This is supported by the information present in the table excerpt in Figure 45 below:

Figure 45. Excerpt from table of analysis of my final recording on Improvisation showing Mod 3 - section B

Section/ Mod. No.	Bar	Time (as per click track)	Time (recording)	Written Tempo	No. of Beats Written *	Performance Tempo Range	Average Performance Tempo	No. of Beats Contained (at written tempo)	Other Issues/ Comments	Next Mod. Given inaccuracy
Mod. 3	17	0.34-0.35	0.30-0.31	♩=168 (𝅗𝅥=84)	2	𝅗𝅥=83 - 86	𝅗𝅥=84	2	Pulse is still stable and written tempo is maintained. Mod. 3 is correct due to this. The 𝅘𝅥𝅯s sit well within the pulse, not wavering as they have in the other performances	♩.♩=60
	18	0.35-0.36	0.31 – 0.32	𝅗𝅥=84	2	𝅗𝅥=83 - 85	𝅗𝅥=84 (𝅘𝅥𝅯𝅘𝅥𝅯𝅘𝅥𝅯=420)	2		
B	19 - 23	0.37 – 0.43	0.33 – 0.40	𝅗𝅥=84	10	♩=81 - 89	♩=85	<10	Pulse remains steady here for the most part, only pushing slightly in some bars	N/A

Small rhythmic inconsistencies start presenting themselves in section C of my final performance with the shortening of a rest value in b. 30, which causes an increase in pulse tempo. However, I manage to stabilise and maintain this slightly faster pulse, something which I had been unable to achieve in my initial performance of *Improvisation*. This ability could be due to the fact that practicing with the click track improved my sense of pulse within the piece and influenced my muscle memory, allowing me to recognise the physical feeling of what it was to play the piece 'in time' and what each section and modulation feels like physically in relation to their surrounding sections. This muscle memory trait may be more pertinent to Carter's *Eight Pieces for Four Timpani* due to the extremely physical nature of playing the timpani and the amount of large body movement that is required to navigate around the instrument, as is the case with many percussion instruments. As result of this set pulse, Mod. 5 is still performed accurately.

Mod. 6 is the first and only modulation in my final performance that is incorrect, even when considering context. The rhythmically accelerating tuplets in section D remain an issue in this recording; these tuplets push the pulse, causing it to accelerate. It continues to do so through Mod. 6, severing the relationship not only between the modulation and the preceding section but also between the bars within the modulation itself, which are unstable as a consequence (this can be seen in the Figure 46 below).

Figure 46. Excerpt from table of analysis of my final recording of Improvisation showing section D - Mod. 6

Section/ Mod. No.	Bar	Time (as per click track)	Time (recording)	Written Tempo	No. of Beats Written *	Performance Tempo Range	Average Performance Tempo	No. of Beats Contained (at written tempo)	Other Issues/ Comments	Next Mod. Given inaccuracy
D	42- 45	1.18-1.28	1.11 – 1.20	𝅗𝅥=48	8	𝅗𝅥=49 - 53	𝅗𝅥=53	9	Pulse accelerates as the subdivision increase in this section, leading to a faster pulse tempo	N/A
Mod. 6	46	1.29-1.30	1.20 – 1.22	♩=48	2	♩=52 - 54	♩=53	<1	Due to the slight but constant increase in the pulse tempo during the previous section, Mod. 6 is performed as a faster tempo than written, and is the first modulation to be inaccurate in this performance	♩=156
	47	1.31-1.32	1.22-1.23	♩=84	2	♩=98 - 106	♩=104	<1		

This acceleration is halted in section E and settles as it did in section C earlier in the performance. This settled pulse remains for the rest of the performance, allowing Mod. 7 – 9 to be performed correctly given the new pulse tempo set in section E.

My ability to perform the last three modulations of the piece may also be attributed to the use of click track and its influence of both my physical and mental understanding of them. By practicing with the click track not only was I able to associate physical traits to each modulation in 'Improvisation' but I was also able to better understand the method in which the pulse is manipulated through them. This refining of my understanding of the rhythmic structures contained in this piece allowed me to better execute each modulation, despite slight changes in the pulse tempo or errors in its manipulation.

The spectrogram and 'Audacity' images of this recording present similar information as the images associated with the other recordings previously discussed but also reinforce the increased accuracy of my final performance.

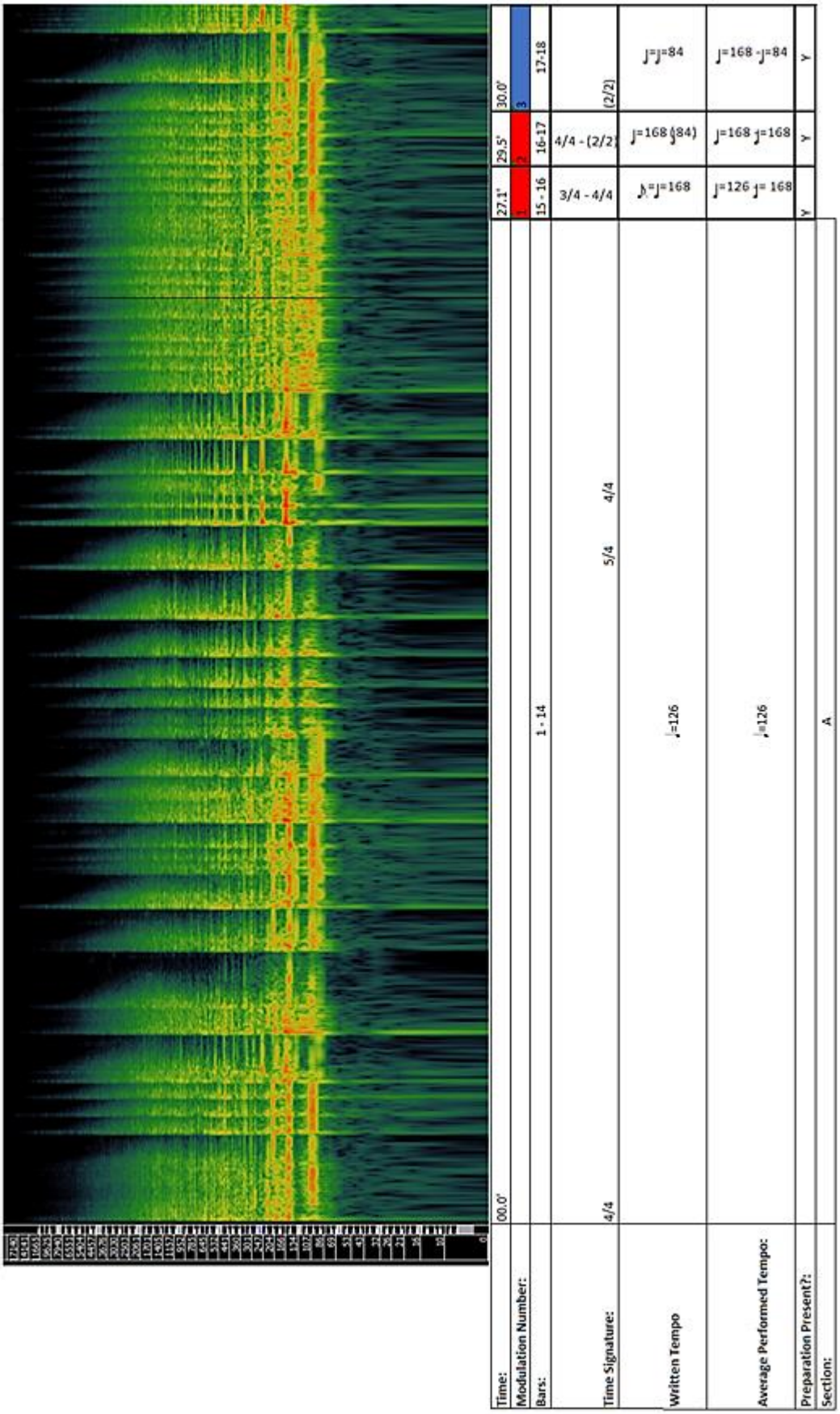
Figure 47. Table containing the analysis of the modulations present in my final performance of Improvisation

Section / Mod. No.	Bar	Time (as per click track)	Time (recording)	Written Tempo	No. of Beats Written *	Performance Tempo Range	Average Performance Tempo	No. of Beats Contained (at written tempo)	Other Issues/ Comments	Next Mod. Given inaccuracy
A	1-14	0.04 – 0.30	0.00 – 0.27	♩= 126	57	♩=124 - 130	♩ = 126	57	Pulse is not quite as stable as it was in the performance with the click track, but is far more stable than it was in the initial performance, resulting in a correct average performance tempo of ♩ = 126	♩ = 168
Mod. 1	15	0.31 – 0. 32	0.27 – 0.28	♩ = 126	3	♩=124 - 127	♩=126	3	The pulse remains steady here and Mod. 1 is performed accurately	𝅗𝅥=84
	16	0.32 – 0.33	0.28 – 0.29	♩ = 168	4	♩ = 162 - 169	♩=168	4		
Mod. 2	16	0.32 – 0.33	0.28 – 0.29	♩ = 168	4	♩ = 162 - 169	♩=168	4	The pulse remains stable here and as a consequence, Mod. 2 is performed correctly. The written tempo has been maintained also, unlike in the initial performance	♩=84 (𝅘𝅥𝅯𝅘𝅥𝅯𝅘𝅥𝅯=420)
	17	0.34 – 0.35	0.30 – 0.31	♩=168 (𝅗𝅥=84)	2	♩=83 - 86	𝅗𝅥=84	2		
Mod. 3	17	0.34 – 0.35	0.30 – 0.31	♩=168 (𝅗𝅥=84)	2	♩=83 - 86	♩=84	2	Pulse is still stable and written tempo is maintained. Mod. 3 is correct due to this. The ♪ 5s sit well within the pulse, not wavering as they have in the other performances	𝅗𝅥𝅗𝅥=60
	18	0.35 - 0.36	0.31 – 0.32	♩=84	2	♩=83 - 85	♩=84 (𝅘𝅥𝅯𝅘𝅥𝅯𝅘𝅥𝅯=420)	2		
B	19 - 23	0.37 – 0.43	0.33 – 0.40	♩=84	10	♩=81 - 89	𝅗𝅥=85	<10	Pulse remains steady here for the most part, only pushing slightly in some bars	
Mod. 4	24	0.44 – 0.45	0.40 – 0.41	𝅗𝅥𝅗𝅥=84	2	𝅗𝅥𝅗𝅥=78 - 84	𝅗𝅥𝅗𝅥=83	2	Pulse slows slightly in b. 24 (this is not audibly noticeable) but stabilises in b. 25 and Mod. 4 is therefore accurate	𝅗𝅥𝅗𝅥=48
	25	0.45 – 0.46	0. 41 – 0.42	𝅗𝅥𝅗𝅥=60	1	𝅗𝅥𝅗𝅥=57 - 63	𝅗𝅥𝅗𝅥=60	1		
C	26 - 39	0.47 – 1.13	0. 42 – 1.07	𝅗𝅥=60	28	𝅗𝅥=60 - 66	𝅗𝅥=64	<26	The pulse increases suddenly in b. 31 due to a shortened rest in b.30. The increase isn't a large one and the pule remains stable at this newly set tempo	N/A
Mod. 5	40	1.14 – 1.16	1.07 – 1.09	♩=120	5	♩=119 -125	♩=122	<5	The pulse settles further after is slight acceleration in the previous section, returning almost to the written tempo. This may be due to the muscle memory and sound profile create by practicing with the click track.	♩=85.75
	41	1.16 – 1.17	1.09 – 1.11	𝅗𝅥𝅗𝅥=48	2	𝅗𝅥𝅗𝅥=48 - 50	𝅗𝅥𝅗𝅥=49	<2		

Section / Mod. No.	Bar	Time (as per click track)	Time (recording)	Written Tempo	No. of Beats Written *	Performance Tempo Range	Average Performance Tempo	No. of Beats Contained (at written tempo)	Other Issues/ Comments	Next Mod. Given inaccuracy
D	42- 45	1.18 – 1.28	1.11 – 1.20	𝅗𝅥=48	8	𝅗𝅥=49 - 53	𝅗𝅥=53	9	Pulse accelerates as the subdivision increase in this section, leading to a faster pulse tempo	N/A
Mod. 6	46	1.29 – 1.30	1.20 – 1.22	♩=48	2	♩=52 - 54	♩=53	<1	Due to the slight but constant increase in the pulse tempo during the previous section, Mod. 6 is performed as a faster tempo than written, and is the first modulation to be inaccurate in this performance	♩=156
	47	1.31 – 1.32	1.22 – 1.23	♩=84	2	♩=98 - 106	♩=104	<1		
E	48-70	1.33 – 1.59	1.23 – 1.46	♩=84	47	♩=101 - 113	♩=104	33	Pulse remains steady throughout this section, albeit at the faster tempo set as a result of Mod. 6	N/A
Mod. 7	71	2.00 – 2.01	1.47 – 1.48	♩=84	2	♩=104 - 107	♩=104	<1	The pulse is kept stable, allowing for a contextually accurate performance of Mod. 7	♩=155
	72	2.01 – 2.02	1.48 – 1.49	♩=126	3	♩=152 - 158	♩=155	<2		
F	73-97	2.02 – 2.37	1.49 – 2.17	♩=126	72	♩=146 - 152	♩=152	62	Pulse slows slightly in this section due to the dragging ♩ rhythms. Some rhythms in b. 89 – 93 are also clipped. Pulse slows again in b. 95 – 96 (to ~ 138)	♩=138 (given tempo from b. 95)
Mod. 8	98	2.37 – 2.38	2.18 – 2.19	♩=126	2	♩=136 - 142	♩=140	<1	The pulse tempo at the 2/4 bars (95 – 96), is maintained throughout this modulation. Allowing for a contextually accurate performance	♩=210
	99	2.38 – 2.39	2.19 – 2.20	♩=126	2	♩=139 - 141	♩=140	<1		
Mod. 9	100	2.39 – 2.40	2.20 – 2.21	♩=126	2	♩=139 - 142	♩=140	<1	The pulse remains stable in Mod. 9, which is therefore performed correctly.	N/A
	101	2.40 – 2.41	2.21 – 2.22	♩=189	4	♩=209 - 214	♩=211	<3		
G	102 -120	2.42 – 3.05	2.22 – 2.45	♩=189	76	♩=195 - 218	♩=209	67	The pulse fluctuates in some sections but ultimately the average performance tempo is relatively constant	N/A

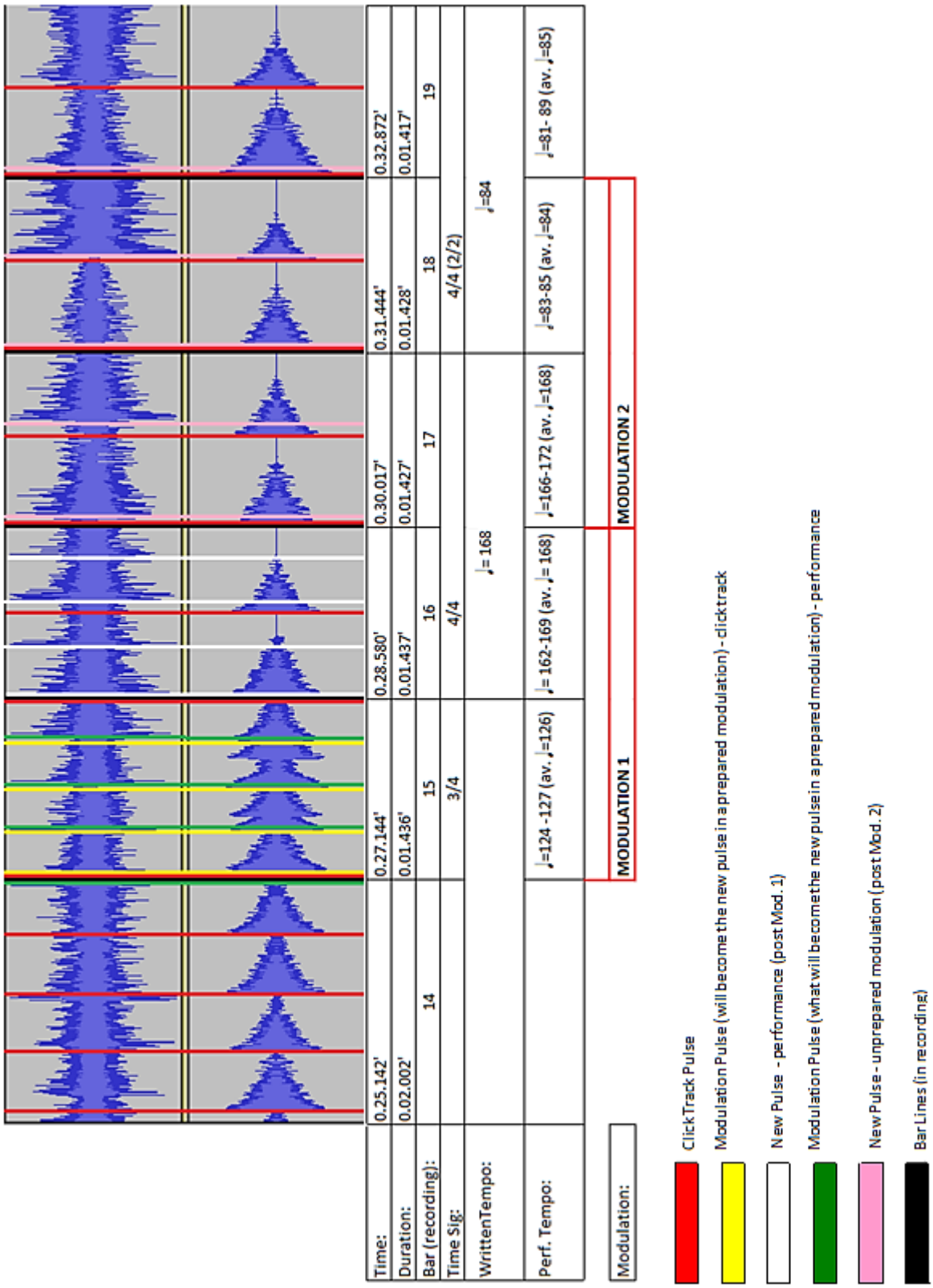
* All beats are performed in this recording

Figure 48. Sample of the spectrogram of my final recording of Improvisation



Time:	00.0'				27.1'	29.5'	30.0'
Modulation Number:					1	2	3
Bars:	1 - 14				15 - 16	16-17	17-18
Time Signature:	4/4	5/4	4/4		3/4 - 4/4	4/4 - (2/2)	(2/2)
Written Tempo	♩=126				♪=♩=168	♩=168 (♩=84)	♩=♩=84
Average Performed Tempo:	♩=126				♩=126 ♩= 168	♩=168 ♩=168	♩=168 ♩=84
Preparation Present?:					Y	Y	Y
Section:	A						

Figure 49. Sample of the 'Audacity' image of my final recording of Improvisation



Chapter 6

Concluding Remarks

All of the recordings studied throughout this dissertation provide valuable information regarding the performance of the complex rhythmic profile of Elliott Carter's *Eight Pieces for Four Timpani*. The performances of *Improvisation* recorded by Sylvio Gualda, Daniel Druckman and Florent Jodelet each provide a contrasting interpretation of the work but also present evidence that the metric and temporal modulations present are difficult to perform accurately, as is the correction of errors associated with this inaccuracy. Therefore, whilst each performance is unique and each contains its own successes and mishaps, all recordings support the argument that something is needed to assist in the execution of these rhythmic structures and that click tracks may be that solution.

Each of my recordings further support this argument; my initial performance of *Improvisation* contained many unstable and incorrect modulations as I struggled to maintain and correctly manipulate the pulse tempo (as many students do). However, these issues were greatly improved once I had applied the click track to my performance – the track provided a stable framework within which to perform the piece and created a reference point for me at various stages in the performance when my pulse deviated from its intended tempo. The click track also allowed me to better understand the relationship between the sections of music effected by the modulations and how the pulse was acting throughout, leading me to be able to execute them more accurately. Furthermore, this increased understanding coupled with practice with the track influenced my physical approach to the piece and my muscle memory, allowing me to replicate a more accurate realisation of the work without the presence of the track. This is evident through the success of my final performance.

My final recording of *Improvisation* was not perfect but was a great improvement on my initial performance, leading me to conclude that the click track was effective and did indeed assist in increasing my rhythmic accuracy throughout the piece. I have therefore concluded that click tracks would be of benefit to the other four pieces in Carter's *Eight Pieces for Four Timpani* that contain metric and temporal modulation as they would act in a similar capacity to what I have experienced with 'Improvisation'. I have also discovered throughout the course of this dissertation the importance of understanding the relationship between time systems created as a result of the modulations in these works, and how the pulse is altered within such modulations – without this understanding it is difficult to perform these structures accurately. The click tracks assisted in increasing my knowledge of these relationships in *Improvisation*, as I am certain they would do with the other Carter timpani works.

It is hoped therefore that this dissertation and the click tracks created as part of it will serve as a tool for other musicians, not only those who wish to study and learn Elliott Carter's *Eight Pieces for Four Timpani* but also for those who are fascinated by metric and temporal modulation as musical processes. Whilst rhythmic accuracy is only one component of an effective and successful interpretation of a piece and is by no means necessarily the most important musical parameter contained in music, rhythm is the framework in which much music exists (even if only indirectly) and must be understood before it can be moulded and manipulated by the performer. This is especially true for Carter's timpani works, which are an exploration into metric and temporal modulation.

I hope that by providing an insight into the rhythmic elements contained in these pieces and creating a tool which can be used by performers to better understand and more accurately perform these structures, that more students and professionals alike will accept the challenge of learning one or more of Carter's *Eight Pieces for Four Timpani* – they are fantastic works that should not be feared for their rhythmic complexities, but rather celebrated for them.

Bibliography

Aylward, John. "Formal Designs in Elliott Carter's Fifth String Quartet: Large-Scale Metric Tensions and the Embedded Tempo & Stillness and Change: A Work in Three Movements for Pierrot Ensemble." Ph.D., Brandeis University, 2008.

Bernard, Jonathan W. "The Evolution of Elliott Carter's Rhythmic Practice." *Perspectives of New Music* 26, no. 2 (1988): 164-203. Bernard, Jonathan W. "The Evolution of Elliott Carter's Rhythmic Practice." *Perspectives of New Music* 26, no. 2 (1988): 164-203.

Boehm Quintette., Walter Piston, Irving Fine, Elie Siegmeister, Vincent Persichetti, Walter Piston, and Elliott Carter. *American Winds, Volume One*. New York: Premier,, 1990. sound recording, 1 sound disc (68 min.) : digital ; 4 3/4 in., PRCD 1006 Premier.

Boland, Marguerite, and John Link. Elliott Carter Studies. Cambridge: Cambridge University Press, 2012. http://ECU.eblib.com.au/patron/FullRecord.aspx?p=977118.

Brandt, William E. "The Music of Elliott Carter: Simultaneity and Complexity." Music Educators Journal 60, no. 9 (1974): 24-32.

Bye, Antony. "Carter's 'Classic' Modernism." *Tempo*, no. 189 (1994): 2-5.

Carter, Elliott. Stewart Marrs on Elliott Carter - Eight Pieces for Four Timpani (Performance and Analysis). USA: GUDMUSE, 2005.

Carter, Elliott. *8 Pieces for Four Timpani (One Player)*. (USA: Associated Music Publishers, Inc.) 1995.

Carter, Elliott. "Improvisation." In *Percussion Vol. 2*, 1978.

———. "Improvisation." In *The Music of Elliott Carter Volume 4*. New York, 2001.

———. "Improvisation." In *Elliot Carter: Eight Pieces for Four Timpani*. Paris, France, 2013.

———. *Stewart Marrs on Elliott Carter - Eight Pieces for Four Timpani (Performance and Analysis)*. USA: GUDMUSE, 2005.

Carter, Elliott, Thomas Hillbish, and University of Michigan Chamber Choir. [from old catalog]. *To Music*. n.p.: New World Records NW 219. p1977., p. on side 1 of 1 disc. 33 1/3 rpm. stereo. 12 in.

Daoust, Timothy James. "Polymeter in Twentieth-Century Music:

A Study in Notational Methods." University of North Carolina, 2008.

David Schiff. "Carter, Elliott." Grove Music Online. Oxford Music Online. Oxford University Press, accessed May 12, 2013, http://www.oxfordmusiconline.com.ezproxy.ecu.edu.au/subscriber/article/grove/music/05030.

Edmund A, Bowles. "The Double, Double, Double Beat of the Thundering Drum: The Timpani in Early Music." Early Music 19, no. 3 (1991): 17.

Elliott Carter. Brass Quintet/ Eight Pieces for Four Timpani. The American Brass Quintet and Morris Lang, 1976, Columbia Y34137, CD.

Elliott, C., and J.W. Bernard. Elliott Carter: Collected Essays and Lectures, 1937-1995. University of Rochester Press, 1997.

Fawcett-Lothson, Amanda. "Elliott Carter's New Approach to the Ancient Practice of Temporal Modulation." M.M., Northern Illinois University, 2012.

Flaherty, Michael G. "Time Work: Customizing Temporal Experience." Social Psychology Quarterly 66, no. 1 (2003): 17-33.

Freeman, Jason, and Andrew Colella. "Tools for Real-Time Music Notation." Contemporary Music Review 29, no. 1 (2010): 101-13.

Ghent, Emmanuel. "Programmed Signals to Performers: A New Compositional Resource." Perspectives of New Music 6, no. 1 (1967): 96-106.

Gilbert, Alan. "Daniel Druckman." http://nyphil.org/about-us/ArtistDetail?artistname=daniel-druckman.

Goldman, Richard Franko. "The Music of Elliott Carter." *The Musical Quarterly* 43, no. 2 (1957): 151-70.

Greenhouse, Bernard, Anthony Makas, Beveridge Webster, George Bennette, Samuel Baron, Ruth Maayani, Elliott Carter, *et al*. *American Masters*. United States: Phoenix,, 1999. sound recording . 1 sound disc : digital ; 4 3/4 in., PHCD 141 Phoenix.

Greschak, John. "Polytempo Music: An Annotated Bibliography.", www.greschak.com/polytempo/ptbib.htm (2003).

Greschak, John. "Tempo Scales in Polytempo Music.", www.greschak.com/polytempo/ptbib.htm (2007): 100

Griffiths, Paul. "Carter, Elliott (Cook)." The Oxford Companion to Music. Oxford Music Online.Oxford University Press, accessed May 12, 2013,http://www.oxfordmusiconline.com.ezproxy.ecu.edu.au/subscriber/article/opr/t114/e119

Holland, James. *Practical Percussion: A Guide to the Instruments and Their Sources*. USA: Scarecrow Press, 2005.

Honing, Henkjan. "Issues on the Representation of Time and Structure in Music." Contemporary Music Review 9, no. 1-2 (1993): 221-38.

Hyun, Soyoung. "A Performance Analysis of Elliott Carter's Cello Sonata." D.M.A., Boston University, 2005.

Iannis Xenakis et al… Percussion Vol. 2. Sylvio Gualda, 1978, Erato STU 71106, CD.

Kim, Y. "Stylistic analysis of Elliott Carter's string quartet no. 5: Aspects of character and rhythm". Boston University, 2006.

Knussen, Sue, and Elliott Carter. "Elliott Carter in Interview." *Tempo*, no. 197 (1996): 2-5.

Kozin, Allan. "Elliott Carter, Composer Who Decisively Snapped Tradition, Dies at 103." *New Work Times*, November 6, 2012 2012, 27A.

Link, John. "Elliott Carter's 'Late Music'?". *Tempo* 62, no. 246 (2008): 2-10.

Meyer, Brad. "Elliott Carter's 'Eight Pieces for Four Timpani': A Comparison of the Original Manuscript and the Published Version." Percussive Notes 50, no. 6 (2012): 10.

Meyer, F., A.C. Shreffler, and Paul Sacher Stiftung. Elliott Carter: A Centennial Portrait in Letters and Documents. The Boydell Press, 2008.

Poudrier, Eve. "Toward a General Theory of Polymeter: Polymetric Potential and Realization in Elliott Carter's Solo and Chamber Instrumental Works after 1980." Ph.D., City University of New York, 2008.

Rosen, Charles. The Musical Language of Elliott Carter. Washington DC: Music Division, Library of Congress, 1984.

Schiff, D. *The Music of Elliott Carter*. CORNELL University Press, 1998.

Seay, Albert. *Notes* 26, no. 3 (1970): 623.

Small, Rosemary. "Elliott Carter's "Eight Pieces for Four Timpani": Descriptive and Interpretative Analysis." D.M.A., University of Hartford, 1987.

Strizich, Robert. "Notation in Elliott Carter's Double Concerto." http://www.ex-tempore.org/strizich/strizich.htm.

Stroppa, Marco. "Live Electronics or…Live Music? Towards a Critique of Interaction." Contemporary Music Review 18, no. 3 (1999): 41-77.

Various (Library of Congress), "Sketches for Cello Sonata." http://www.loc.gov/resource/ihas.200155639#seq-2

Vickery, Lindsay. "Mobile Scores and Click-Tracks: Teaching Old Dogs.", Australiasian Computer Music Conference, (ANU: Canberra), 2011.

———. "The Possibilities of Novel Formal Structures Through Computer Controlled Live Performance", Australiasian Computer Music Conference, (ANU: Canberra), 2011.

Wierzbicki, J. *Elliott Carter*. University of Illinois Press, 2011.

Williams, Jan. "Elliott Carter's "Eight Pieces for Four Timpani" - the 1966 Revisions." *Percussive Notes* 6, no. 38 (2000): 10.